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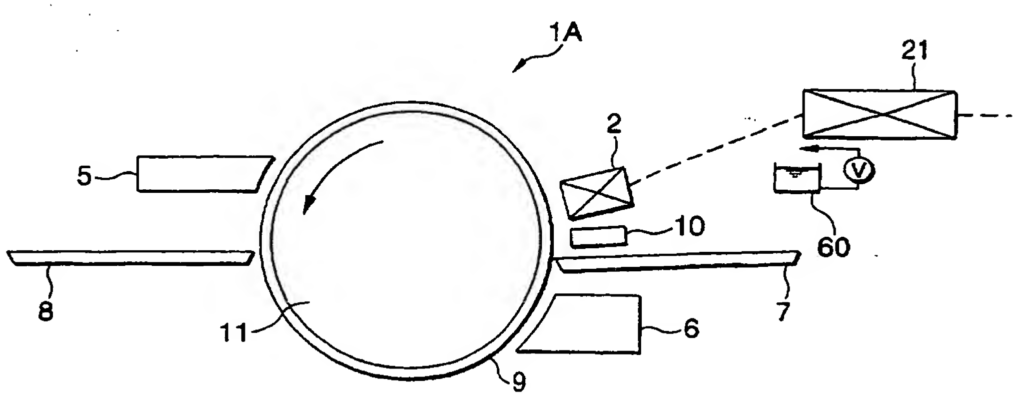
(54) Abstract Title
Plate making method and plate making apparatus

(57) A method of making a printing plate based on image data signals comprising: directly forming an image on a plate material (9) by an electrostatic inkjet process comprising ejecting an oil-based ink from an ink ejecting head (2) by making use of an electrostatic field (60); and fixing the image thus formed at (5), is disclosed. The method of the invention further comprises cleaning said ejecting head by immersing the ejecting head (2) in a cleaning liquid (57, Fig. 11) and applying voltage thereto. Alternatively, the method of the invention further comprises, in the case where an anomaly takes place, at least one of suspending the image formation and eliminating a cause of said anomaly. Also disclosed are plate making apparatuses for carrying our the methods.

FIG. 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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FIG. 1

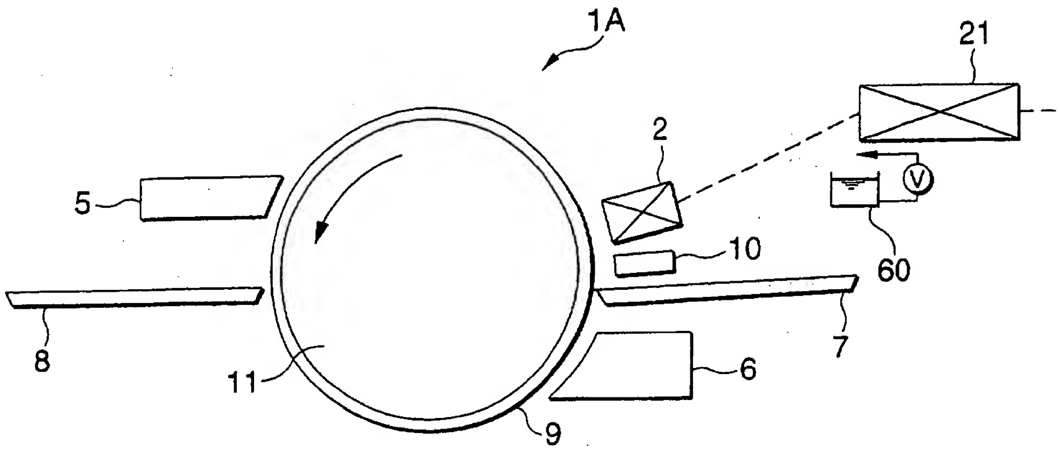

FIG. 2

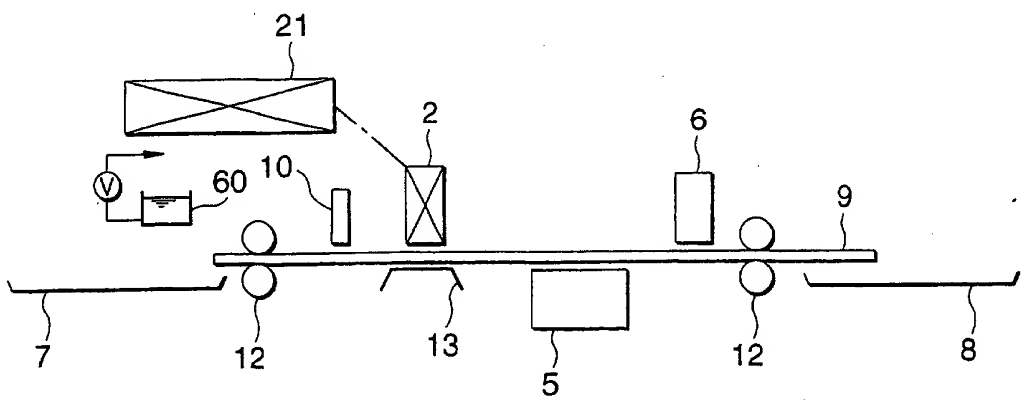

FIG. 3

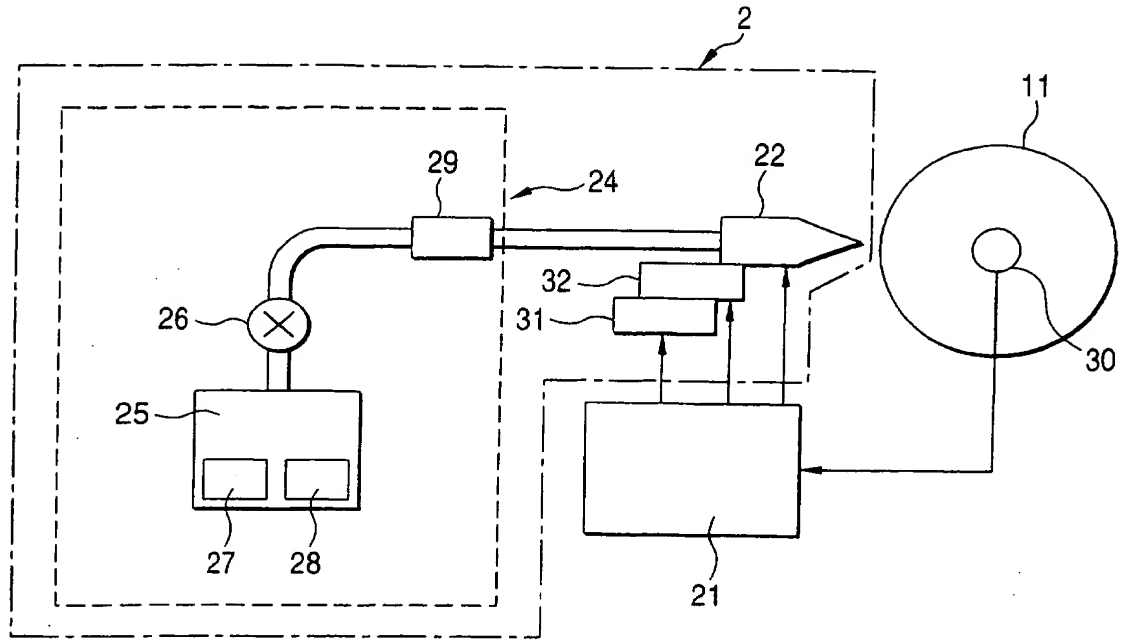

FIG. 4

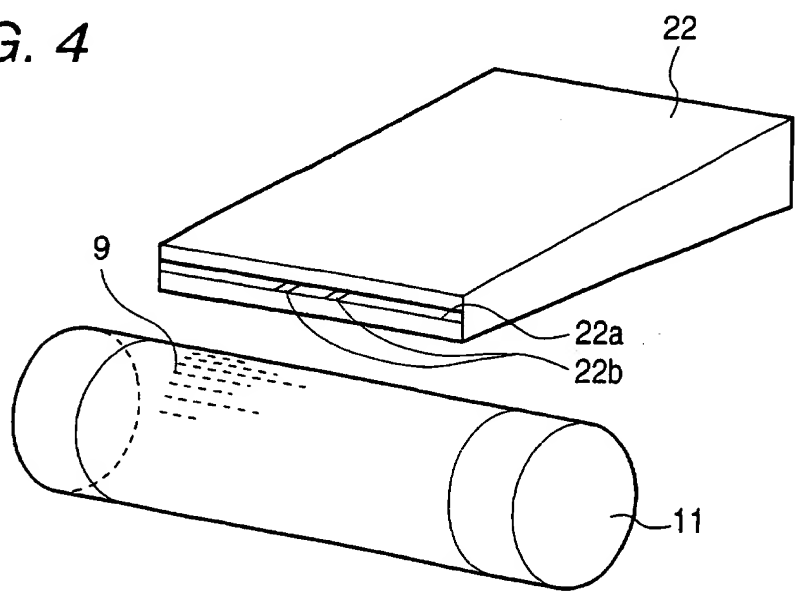

FIG. 5

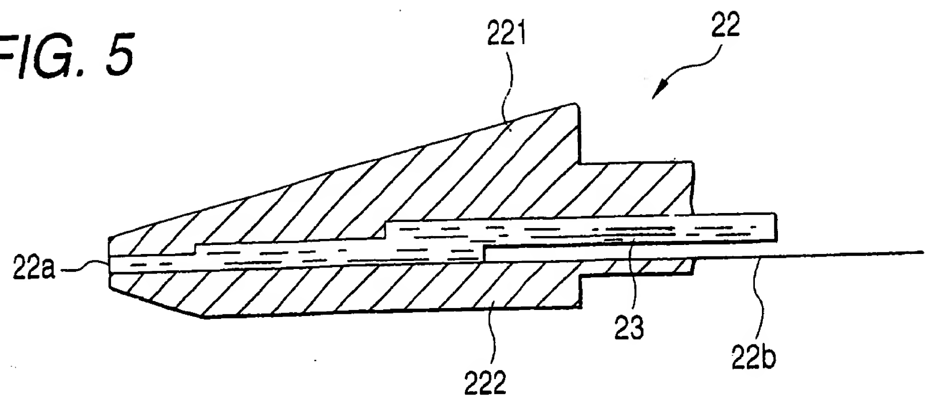

FIG. 6

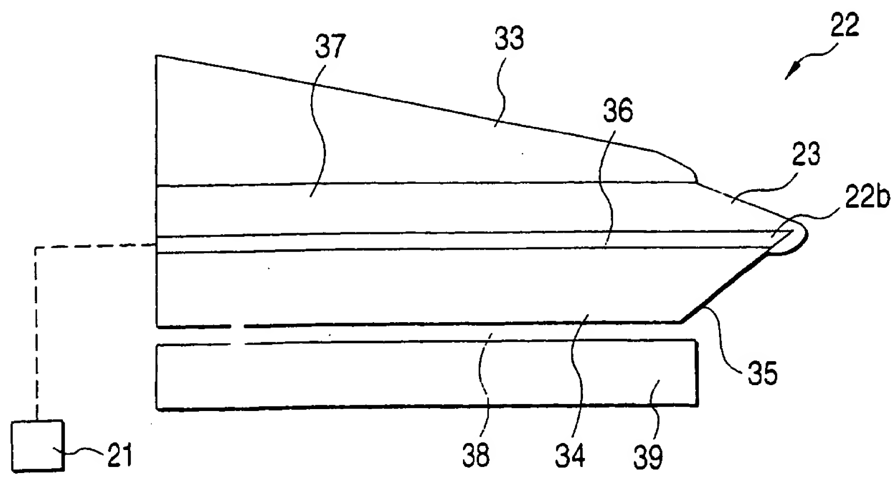

FIG. 7

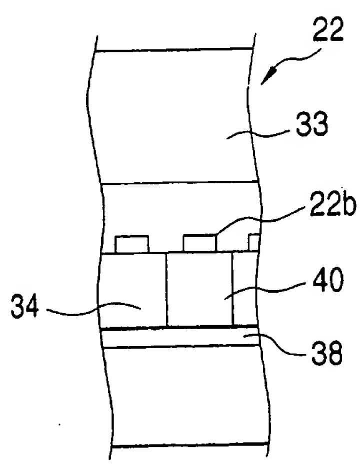

FIG. 8

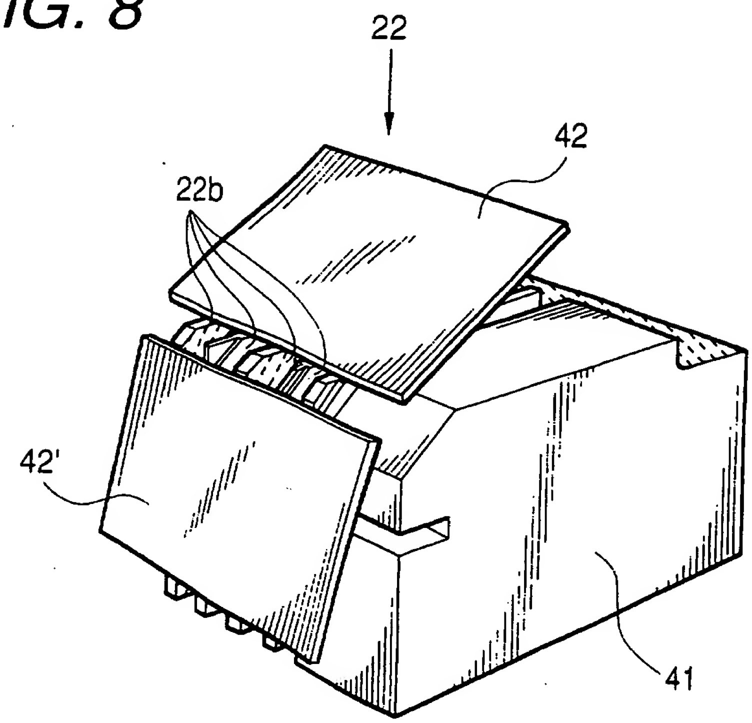

FIG. 9

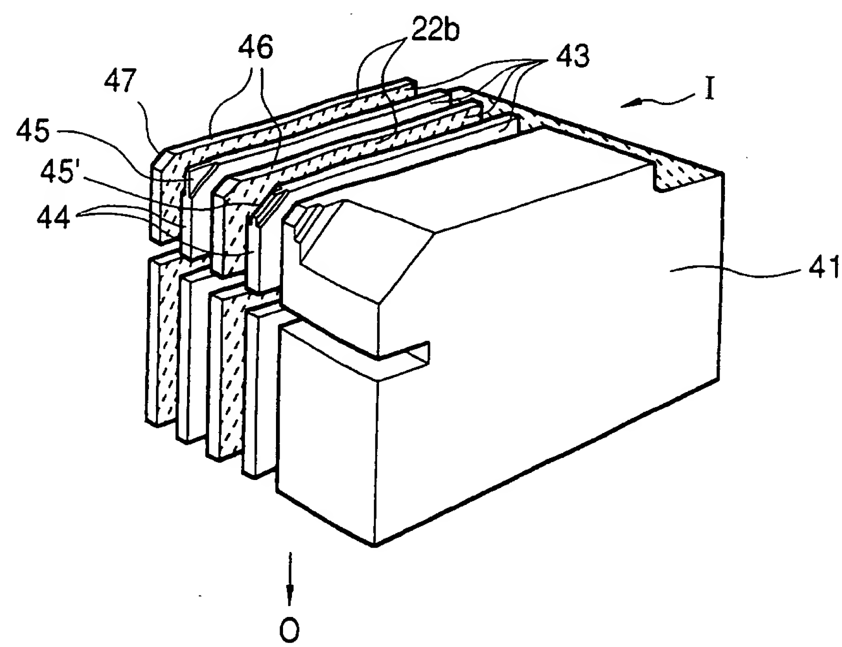

FIG. 10

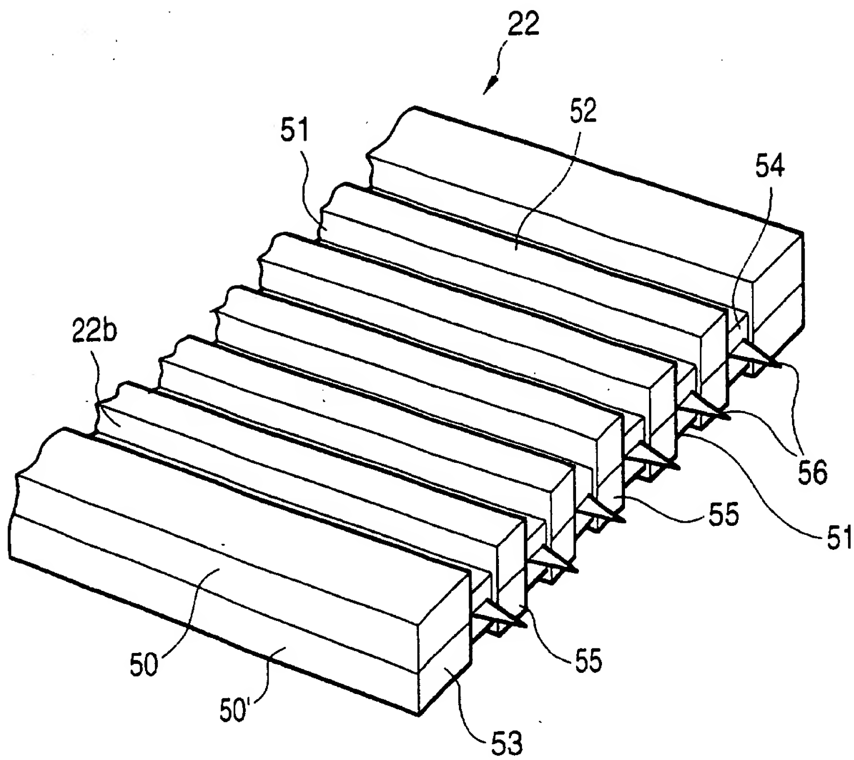

FIG. 11

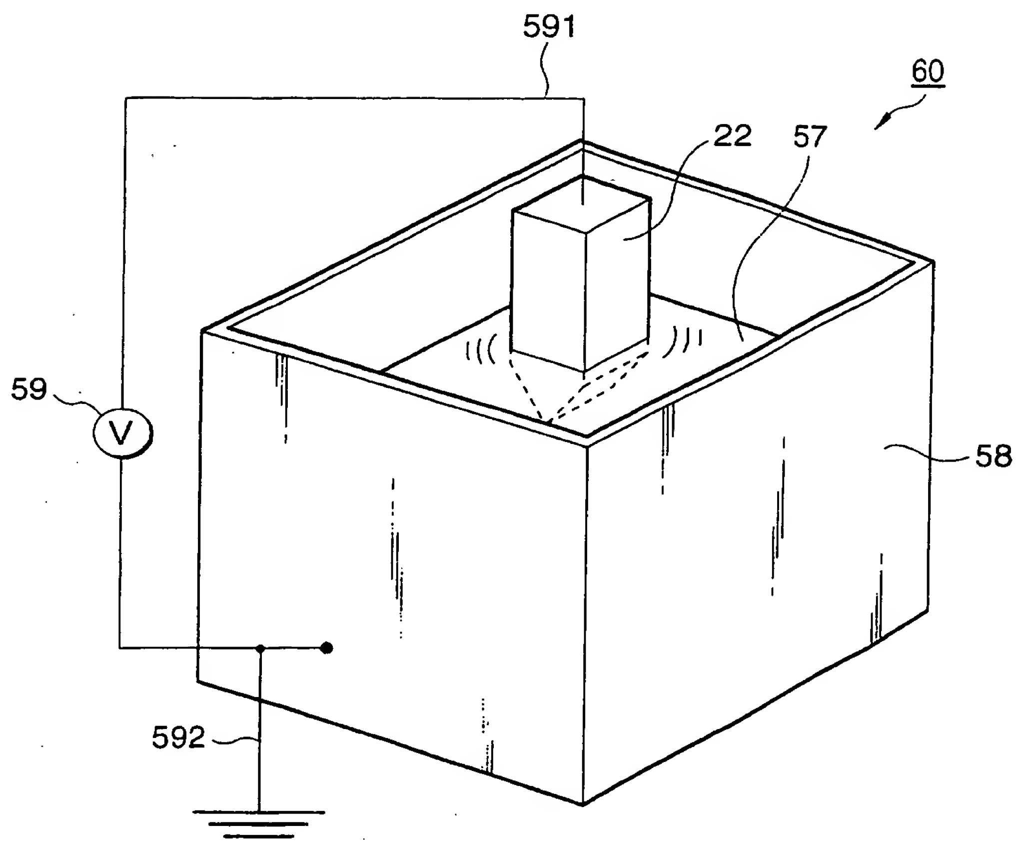

FIG. 12

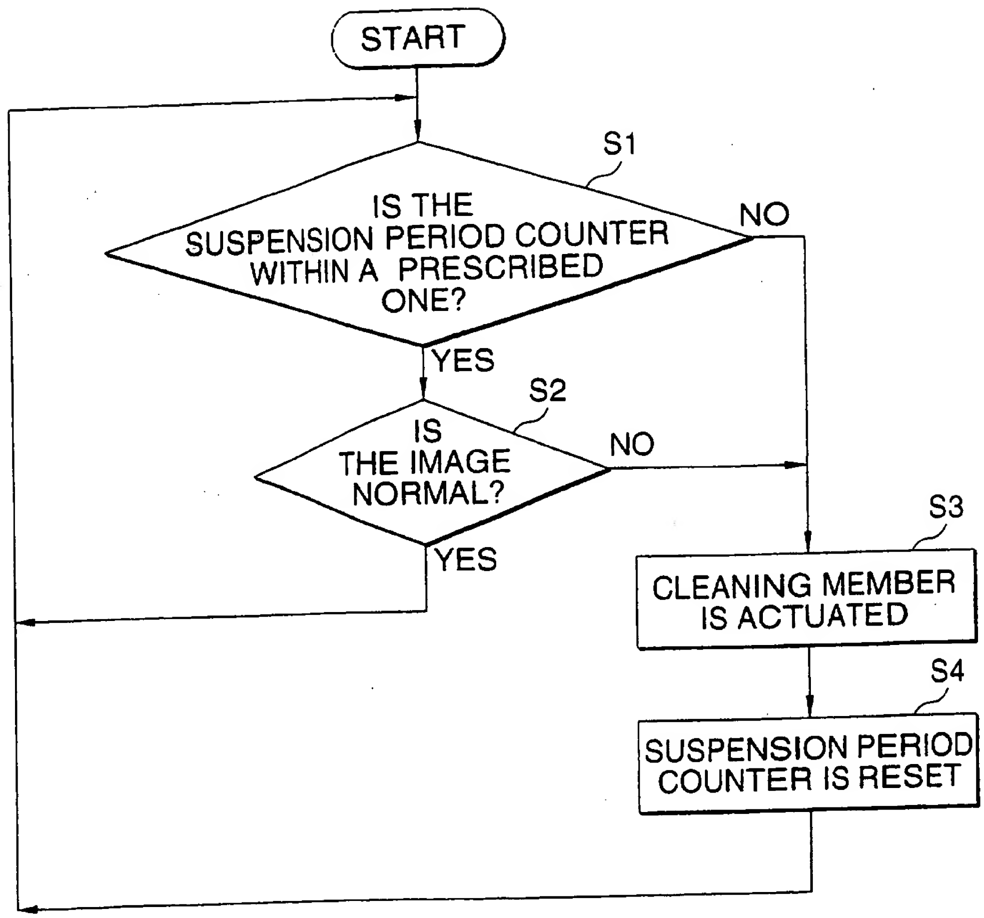
START
S1
IS THE SUSPENSION PERIOD COUNTER WITHIN A PRESCRIBED ONE?
NO
YES
S2
IS THE IMAGE NORMAL?
NO
YES
S3
CLEANING MEMBER IS ACTUATED
S4
SUSPENSION PERIOD COUNTER IS RESET

FIG. 13

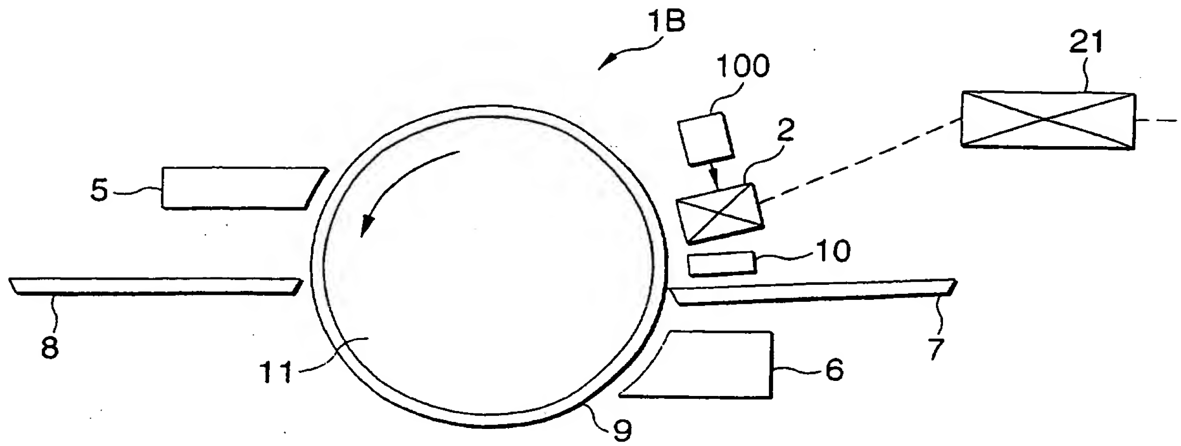

FIG. 14

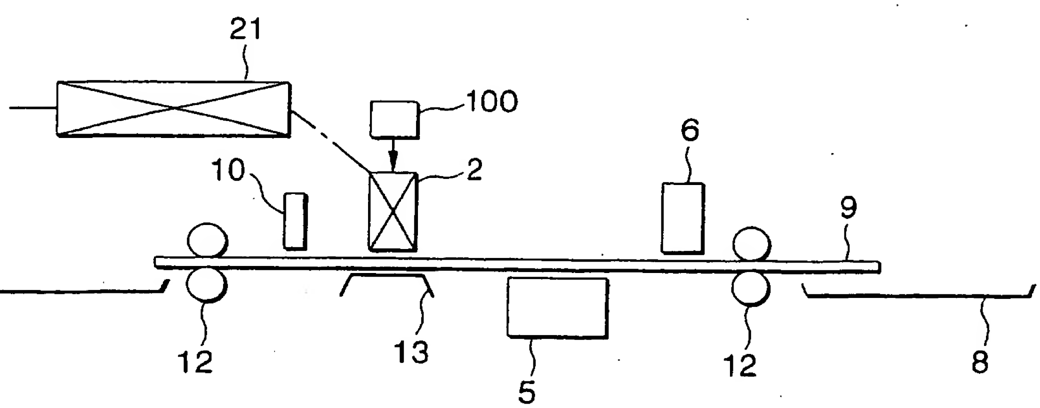

FIG. 15

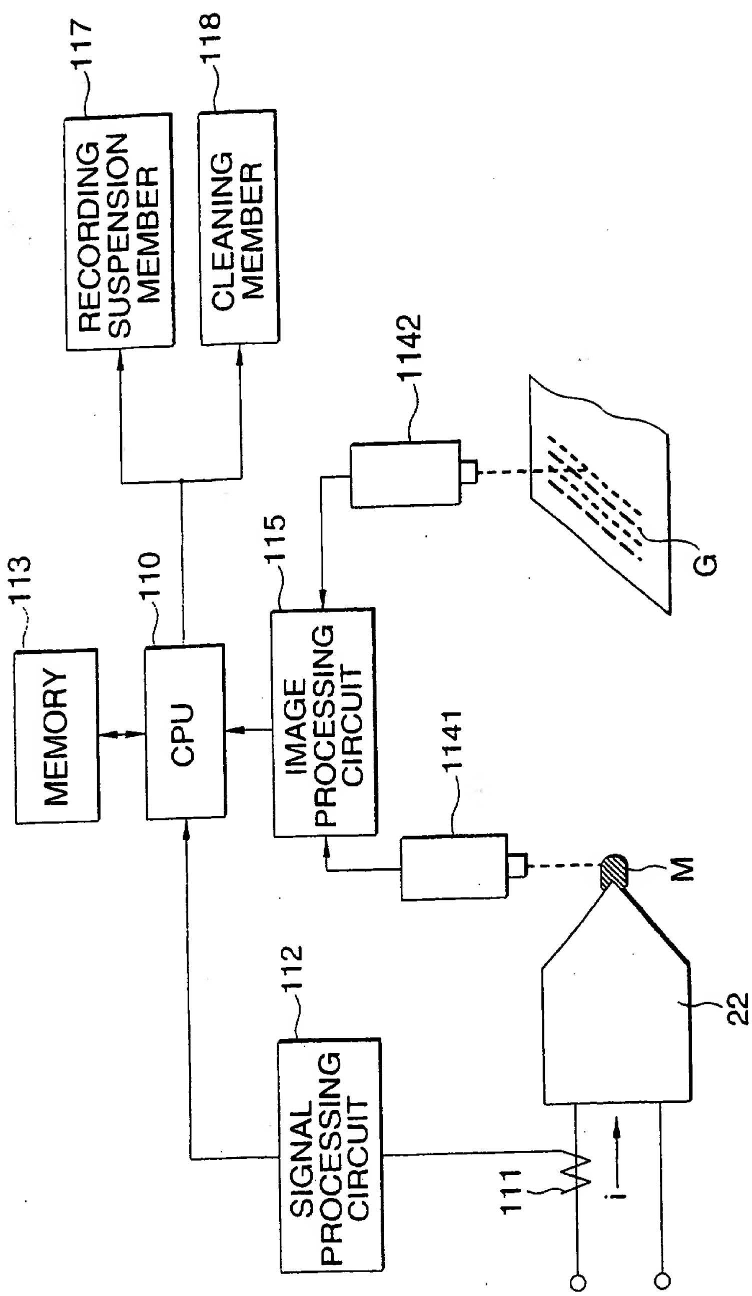
117
RECORDING SUSPENSION MEMBER
118
CLEANING MEMBER
113
MEMORY
110
CPU
115
IMAGE PROCESSING CIRCUIT
1142
G
1141
M
112
SIGNAL PROCESSING CIRCUIT
22
111
i

FIG. 16

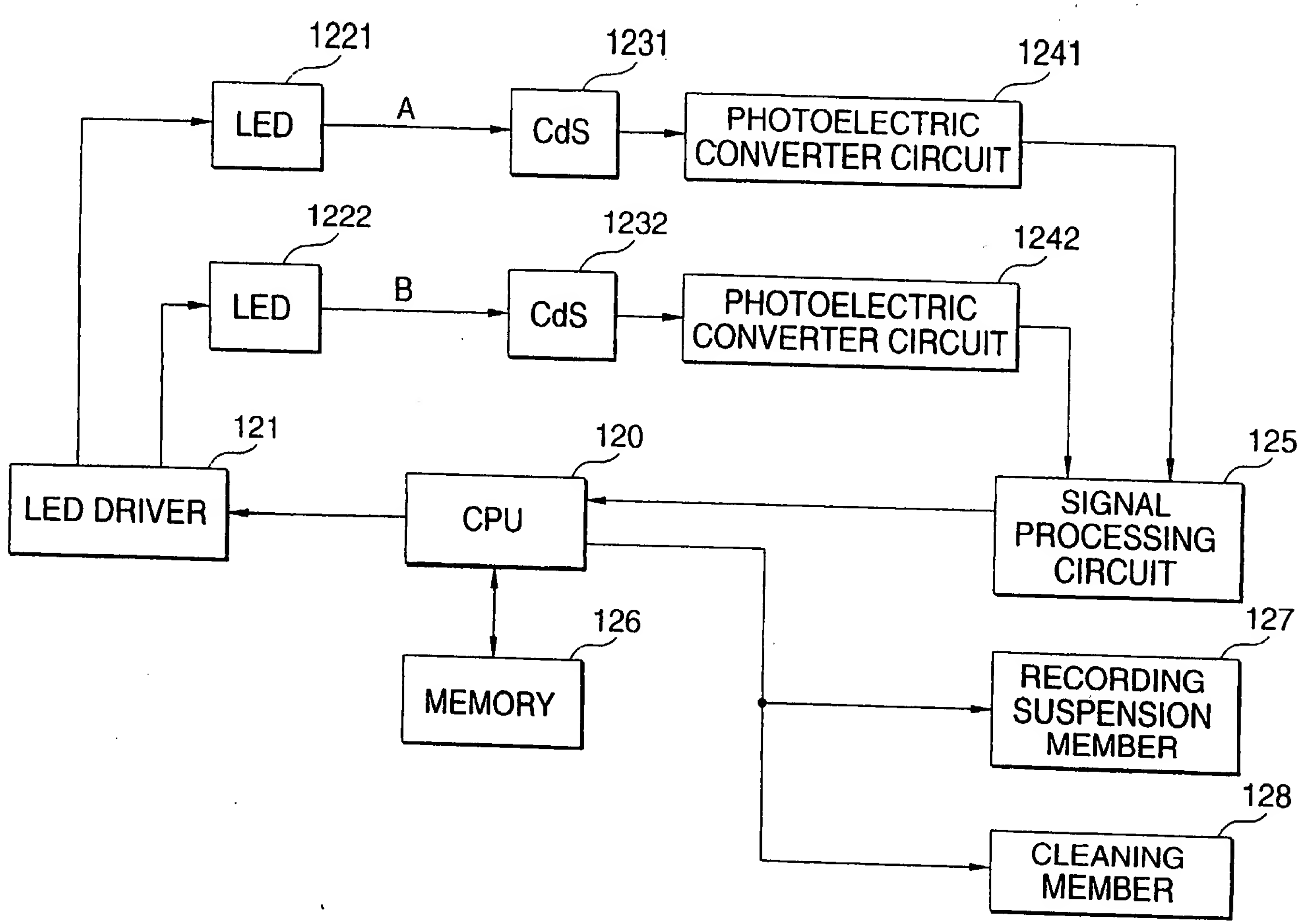
1221
LED
A
1231
CdS
1241
PHOTOELECTRIC CONVERTER CIRCUIT
1222
LED
B
1232
CdS
1242
PHOTOELECTRIC CONVERTER CIRCUIT
121
LED DRIVER
120
CPU
125
SIGNAL PROCESSING CIRCUIT
126
MEMORY
127
RECORDING SUSPENSION MEMBER
128
CLEANING MEMBER

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PLATE MAKING METHOD AND PLATE MAKING APPARATUS

The present invention relates to a method and an apparatus for carrying out digital plate making, and particularly to such a method and apparatus using an oil-based ink and capable of providing high quality plates as well as high quality printed matter.

In the conventional lithographic printing, an ink-receptive area and an ink-repelling area are formed on the surface of a printing plate, and a printing ink is fed on the plate so as for the ink to selectively adhere to the ink-receptive area. The adhering printing ink is then transferred to paper. Usually, the hydrophilic area and the oleophilic (ink-receptive) area are formed imagewise on the surface of a printing plate. Then, the hydrophilic area is moistened with dampening water to repel the printing ink.

Image recording (plate making) on the printing plate material is carried out, as the most popular method, by first outputting an original image on a silver halide photographic film via an analog or a digital method, through which a photosensitive diazo resin or a

photopolymer-based layer is exposed to light, and removing such a photosensitive layer at the non-image areas with an alkaline developer.

Recently, with the advance of digital image formation technology and with the demand for a higher efficiency of printing work, a variety of proposals are being made on a system that can directly output images on printing plate using digital image information. Such methods are often called CTP (Computer-To-Plate), or DDPP (Digital Direct Printing Plate). Plate making methods suitable for CTP includes light or heat mode image recording systems using, for example, laser exposure, and some of them are being in practical use.

However, such plate making methods including both the light and heat modes based on laser exposure suffer from an environmental drawback caused by the use of alkaline developer needed to remove background areas of the plate material after the image exposure.

Those plate making methods based on laser exposure generally require an expensive and bulky apparatus. Hence, systems based on inkjet imaging are attracting attention as it uses an inexpensive and compact image recording apparatus.

JP-A-64-27953 (The term "JP-A" used herein means an "unexamined published Japanese patent application")

discloses a plate making method comprising image formation by inkjet recording using an oleophilic wax ink onto a hydrophilic plate material. However, the wax image made by this method suffers from a poor print durability because waxes are mechanically weak and poorly adhere to the hydrophilic plate surface.

In order to obtain high quality images consistently, the ejecting condition of an inkjet head must be optimally maintained. Along with a prolonged use of the head, some ink ingredients tend to adhere to the head, and such ingredients must be removed. Conventionally, the head was subjected to cleaning operation when the use time thereof passed over a fixed operation time, or when image deterioration took place. With such maintenance, it accidentally happens that the head in a deteriorated condition is used for recording, and certain ingredients become solidified on the head, sometimes standing ordinary cleaning operations. When cleaning operations fail to work perfectly, the frequency of cleaning must be increased, or else undesirably adhered deposits will accumulate, thus shortening head life noticeably.

In addition, to obtain high quality images consistently, ink droplets must be ejected accurately. For that purpose, a head that has a highly precise

meniscus shape is required and at the same time, such a head must be located close to the plate material to record fine dots. Therefore, dust deposition on the head will not only deform the meniscus shape hindering an accurate ejection of ink droplets, but also bring the head in contact with the plate material prohibiting ink ejection. In particular, with an ejecting mechanism based on electrostatic field wherein the plate material supporting member such as drum is electrically conductive, the head contact will short-circuit to damage the plate material as well as the supporting member. Further, the dust floating above the plate material also has an adverse effect on high quality image formation. In the case where some defects are formed in the recorded image on the plate material due to such reasons, the plate making operation must be suspended and the cause of the defects must be eliminated.

The invention has been made to solve the above-described problems.

Accordingly, an object of the present invention is to provide a method and apparatus for digital plate making not requiring any photographic processing.

Another object of the present invention is to provide a method and apparatus for plate making capable of forming high quality images on plate materials with inexpensive and simple methods.

Other objects and effects of the present invention will become apparent from the following description.

(1) In a first aspect, the present invention relates to a method of making a printing plate based on image data signals comprising:

directly forming an image on a plate material by an electrostatic inkjet process comprising ejecting an oil-based ink from an ink ejecting head by making use of an electrostatic field;

fixing the image thus formed; and

cleaning said ejecting head by immersing the ejecting head in a cleaning liquid and applying voltage thereto.

The first aspect of the present invention also relates to a plate making apparatus comprising:

an image forming unit which forms an image directly on a plate material based on image data signals, said image forming unit comprising an inkjet recording unit having an ink ejecting head, which inkjet recording unit ejects an oil-based ink from an ink ejecting head by making use of an electrostatic field;

an image fixing unit which fixes the image formed by said image forming unit; and

a cleaning member for said ejecting head, which comprises a cleaning liquid and applies a voltage on the ejecting head immersed in said cleaning liquid.

(2) In a second aspect, the present invention relates to a method of making a printing plate based on image data signals comprising:

directly forming an image on a plate material by an electrostatic inkjet process comprising ejecting an oil-based ink from an ink ejecting head by making use of an electrostatic field;

fixing the image thus formed; and

in the case where an anomaly takes place, at least one of suspending the image formation and eliminating a cause of said anomaly.

The second aspect of the present invention also relates to a plate making apparatus comprising:

an image forming unit which forms an image directly on a plate material based on image data signals, said image forming unit comprising an inkjet recording unit having an ink ejecting head, which inkjet recording unit ejects an oil-based ink from an ink ejecting head by making use of an electrostatic field;

an image fixing unit which fixes the image formed by said image forming unit; and

at least one of an anomaly detecting member and an anomaly cause eliminating member so that the operation of said image forming unit is at least temporarily suspended and/or said anomaly cause eliminating member operates in response to an output signal from said anomaly detecting member.

In a preferred embodiment of the second aspect of the present invention, said anomaly detecting member is a detector that detects adhesion of foreign matters on the ink ejecting head, a dust detector that detects dust present either or both of in said apparatus and on said plate material, or a vibration detecting device that detects vibration of at least one of said plate making apparatus and said ink ejecting head.

The plate making apparatus according to the second aspect of the invention preferably further comprises a cleaning member which cleans the ink ejecting head.

In both of the first and second aspects of the present invention, said oil-based ink preferably comprises: a non-aqueous solvent having a specific resistance not less than 10^9 Ωcm and a dielectric constant not higher than 3.5; and a hydrophobic particulate resin

dispersed in said solvent, the resin being solid at least at room temperature.

The image fixing unit for use in the invention preferably comprises a heating member having at least one member selected from a heat roller, an infrared lamp, a halogen lamp and a xenon flash lump.

The image heating member is preferably disposed and/or controlled so as to gradually raise the temperature of the plate material upon image fixing.

In a preferred embodiment, the plate making apparatuses of the invention further comprise a drum onto which said plate material is to be loaded, said drum being rotatable to carry out main scanning, and the ink ejecting head comprises a single-channel head or a multi-channel head, each movable in a direction parallel to the axis of said drum to carry out sub-scanning.

In another preferred embodiment, the plate making apparatuses further comprise at least one pair of capstan rollers to carry out sub-scanning by conveying said plate material, and the ink ejecting head comprises a single-channel head or a multi-channel head, each movable in a direction perpendicular to the conveyance direction of said plate material to carry out main scanning.

In these preferred embodiments regarding scanning, the ink ejecting head may be a full-line head having a

length substantially the same as the width of said plate material.

The inkjet recording unit for use in the present invention preferably further comprises at least one of: an ink feeding member which feeds the oil-based ink to said ink ejecting head; an ink recovering member which recovers the oil-based ink from said ejecting head to circulate the oil-based ink; an ink tank for storing the oil-based ink and a stirring member which stirs the oil-based ink in said ink tank; an ink tank for storing the oil-based ink and an ink temperature controller for the oil-based ink in said ink tank; and an ink concentration controller for the oil-based ink.

The plate making apparatuses of the present invention preferably further comprises a dust removing member which removes dust present on said plate material during or prior to said image formation.

Particular embodiments in accordance with this invention will now be described with reference to the accompanying drawings; in which:-

Fig. 1 schematically illustrates the entire construction of an example of the plate making apparatus for use in the first aspect of the invention.

Fig. 2 schematically illustrates the entire construction of another example of the plate making apparatus for use in the first aspect of the invention.

Fig. 3 schematically illustrates the construction of an example of the image recording unit of the plate making apparatus for use in the invention.

Fig. 4 schematically illustrates the construction of an example of an ink ejecting head equipped in an inkjet recording unit for use in the invention.

Fig. 5 schematically illustrates a cross-sectional view around the ejecting point of the head shown in Fig. 4.

Fig. 6 schematically illustrates a cross-sectional view around the ejecting point of another example of the head installed in the inkjet recording unit for use in the invention.

Fig. 7 is a schematic front-end view showing the neighborhood of the ejecting point of the head shown in Fig. 6.

Fig. 8 schematically illustrates the main portion of another example of the ejecting head equipped in the inkjet recording unit for use in the invention.

Fig. 9 schematically illustrates the ejecting head shown in Fig. 8 from which the regulating plates have been removed.

Fig. 10 schematically illustrates the main portion of another example of the ejecting head installed in the inkjet recording unit for use in the invention.

Fig. 11 is a illustration for explaining the cleaning member for use in the first aspect of the present invention.

Fig. 12 is a flow chart for explaining the working mechanism of the cleaning member as shown in Fig. 11.

Fig. 13 schematically illustrates the entire construction of an example of the plate making apparatus for use in the second aspect of the invention.

Fig. 14 schematically illustrates the entire construction of another example of the plate making apparatus for use in the second aspect of the invention.

Fig. 15 is a block diagram of the anomaly detector that detects anomalies such as those in the ink meniscus of the ejecting head, for use in the second aspect of the present invention.

Fig. 16 is a block diagram for the dust detector that detects foreign matters such as dust, for use in the second aspect of the present invention.

In the following, embodiments of the invention will be described in more detail below.

The invention has a feature that image formation is carried out by an inkjet recording method in which an oil-based ink is ejected by an electrostatic field.

In the invention, the size of ink droplet is determined by the dimension of the tip end of an ejecting electrode, or by the conditions of electrostatic field formation. Thus, by using a small electing electrode or by adjusting the electrostatic field forming conditions, one can realize minute ink droplets without reducing the ink ejecting nozzle diameter or slit width. Accordingly, a fine control is possible in image formation without accompanying the drawback of nozzle choking with ink. Based on such an inkjet recording method, the invention provides a plate making method and apparatus that can produce printing plates from which crisp and sharp prints can be made in a large number.

Now, an example of the plate making apparatus for use in the plate making method of the invention is described below.

Figs. 1 and 2 show the entire construction of the plate making apparatus according to the first aspect of the present invention. On the other hand, Figs. 13 and 14, show the entire construction of the plate making apparatus according to the second aspect of the present invention. Fig. 3 shows schematically the image recording unit for use in the present invention, including a control unit, an ink feeding unit and a head distancing/approximating mechanism of the present apparatus. Fig. 4 to Fig. 10 are

given to explain the inkjet recording unit installed in the plate making apparatus shown in Fig. 1, Fig. 2, Fig. 13 or Fig. 14. Fig. 11 and Fig. 12 depict the cleaning member associated with the invention. Fig. 15 is a block diagram of a detecting member detecting the anomalies such as those in the meniscus of the ejecting head. Fig. 16 is a block diagram of another detector for dust.

The plate making procedures according to the invention will be described with reference to plate making apparatuses 1A and 1B shown in Figs. 1 and 13 in which a plate material is loaded on recording drum 11. However, the scope of the invention is not limited to this embodiment at all.

Drum 11 is usually made of metal such as aluminum, stainless steel or iron, plastic, or glass. The surface of a metal cylinder may be plated with chromium or converted to alumite for a better wear resistance. Drum 11 may be covered with an adiabatic material. For electrostatic ink ejection, drum 11 is desirably kept at the earth potential as it acts as the counter electrode of the ejecting electrode. On the other hand, when the base material of the plate is highly electrically insulating, an electro-conductive layer should preferably be provided on the base, in which case an earth terminal is preferably provided on the conductive layer. Further, even in the

case where an adiabatic material is used on drum 11, image recording is facilitated with an earth terminal provided in the plate material. Earth connection can be achieved with a brush, a board spring or a roller made of conductive materials.

Further, plate making apparatuses 1A and 1B have inkjet recording unit 2, which ejects an oil-based ink onto plate material 9 loaded on drum 11 in response to the image data sent from image data processing and control unit 21.

Plate making apparatuses 1A and 1B have fixing unit 5 that acts to make the oil-based ink image formed on plate material 9 wear resistant, and may have desensitizing unit 6 that enhances the hydrophilic nature of the surface of plate 9. Plate making apparatuses 1A and 1B have furthermore dust-removing member 10 that removes dust present on the plate material surface prior to or during recording. With such means, a high quality recording can be performed by preventing undesirable ink deposition conveyed via the surface of dust lying between the head and the plate during recording. Dust can be removed by any method known in the art including non-contact ones such as air suction, blow-off or electrostatic removing, and contact ones using a brush or a roller. Among them, the most preferable method is air

suction or air blow. These methods can be applied separately or in combination. Plate making apparatus 1A according to the first aspect of the invention further has cleaning member 60 to clean the ejecting head. A detailed description on cleaning member 60 will be given later.

Plate making apparatuses 1A and 1B may further have automatic plate loader 7 that automatically loads plate material 9 onto drum 11, and automatic plate unloader 8 that automatically unloads plate 9 from drum 11 after printing operation has finished. The advantageous features of the invention can be enhanced with the use of automatic plate loader 7 and automatic plate unloader 8 because the printing operations become easy and the turnaround time is shortened.

Referring to Figs. 1 and 13 and partially to Fig. 3, the plate making process using plate making apparatuses 1A and 1B will be explained below.

First, plate material 9 is loaded on drum 11 with use of automatic plate loader 7. The loading operation can be carried out by a mechanical method such as grasping the leading or trailing edge of the plate material or with an air sucking device, or by an electrostatic method, both well known in the art. As the entire area of the plate material is fixed on the drum in an intimate contact with it, the trailing edge of the plate material will never

flap, thus not damaging inkjet recording unit 2 arranged closely to the drum during recording. Alternatively, a similarly desirable condition can be realized by keeping the plate material in an intimate contact with the drum only at a limited area including the recording position of the inkjet recording unit. Practically, for example, plate-suppressing rollers may be arranged at the upstream and downstream side near the recording position. Further, in the recording down time, the head should preferable be separated from the plate material to prevent inkjet recording unit 2 from damaging caused by an accidental contact.

Image data processing and control unit 21 receives image data from image scanners, magnetic disk devices or image data transmission devices, and, when needed, separates color information, and divides each color-separated data into suitable pixels and gradation levels. Further, in order to output oil-based halftone inkjet images by using ink ejecting head 22 (See Fig. 3, a detailed description will be given later.) in inkjet recording unit 2, area coverage values are also calculated. Image data processing and control unit 21 also controls the movement of inkjet head 22, the ejection timing of oil-based ink, and, when required, the rotation timing of drum 11.

These calculated data sent to image data processing and control unit 21 are once stored in a buffer memory. Image data processing and control unit 21 rotates drum 11, and moves inkjet head 22 using head distancing/approximating unit 31 to a position close to drum 11. The spacing between the head 22 and the surface of plate material 9 loaded on drum 11 is kept at a pre-determined value during recording by mechanical control with a knocking roller, or by controlling the motion of the head by the head distancing/approximating unit driven by the signal from an optical spacing detector. Owing to such a spacing control, the recorded dot size would not fluctuate even when the plate floats from the drum or when a vibration is applied to the plate making apparatus.

Ejecting head 22, which may be of single-channel type, multi-channel type, or of full line type, performs main scanning by the rotation of drum 11. In cases where the head is of multi-channel type or has a full line width, both having plural ejecting points, those points are arranged along the axial direction of drum 11. In the case of a single-channel or a multi-channel head, head 22 is moved along the drum axis after every drum rotation by image data processing and control unit 21, and an oil-based ink is ejected onto plate material 9 loaded on drum 11 so as to achieve the area coverage values at the

calculated positions. In this manner, a halftone image comprising the oil-based ink and reproducing the density distribution of the original is formed on plate material 9. Such an operation continues until an ink image corresponding to a single color for the original completes. On the other hand, in the case of a full line width head, every rotation of the drum completes the formation of a single color image for the original on plate material 9. In this case, the drum rotates to carry out main scanning whereby the positional accuracy is high and the recording speed becomes very high.

Then, ejecting head 22 is driven to retreat away from the recording position close to drum 11 for head protection. The head distancing/approximating member acts to separate the recording head at least by 500 μm from the drum surface when the head is not in use. Such an advance-and-retreat motion may be performed with a sliding mechanism, or with an arm fixed to a certain axis and rotating the arm around the axis to cause a pendulum-like movement of the head. With such a head retreat during its suspension, the ejecting head is protected from physical damage or contamination, thus operating for a long life.

The mechanical durability of the oil-based image thus formed is improved with fixing unit 5. Image fixing can be performed by various methods known in the art such

as heat or solvent fixation. For heat fixation, irradiation with an infrared lamp, a halogen lamp or a xenon flash lamp, heated air fixing or heat roll fixing can be adopted. To raise fixing efficiency, the following measures are useful which may be used individually or in combination; preliminary heating of the drum or material 9, application of hot air during recording, coating of drum 11 with an adiabatic material and isolation of plate 9 from drum 11 during the heating of plate 9. Flash fixing with a xenon lamp, well known as a fixing method for electrophotographic toner, has an advantage of a very short fixing time. When the base of the plate is made of paper, a rapid temperature rise promotes an abrupt moisture vaporization to cause blisters in the plate surface. To avert blister formation, the temperature of such a paper-based plate material should preferably be raised gradually by slowly increasing the power supply to the heat source while the drum rotates at a constant speed, or decelerating the drum speed with a constant power supply to the source. Alternatively, a stepwise temperature rise can be achieved by arranging multiple fixing unit along the rotating direction of drum 11 whereby the distance from each member to the drum surface and/or the power supplied to each member is appropriately adjusted.

In solvent fixation, a solvent such as methanol or ethyl acetate that can dissolve the resinous ingredient in the ink is brought into contact with the plate in the form of spray mist or vapor, followed by the collection of the excess.

It is desirable to keep the oil-based image formed on plate material 9 not in contact with anything after the image formation with ejecting head 22 and at least until the image is fixed with fixing unit 5.

An example of the structure of a plate making apparatus that carries out sub-scanning by moving plate material 9 will now be described with reference to Fig. 2, but it does not limit the scope of the invention.

On plate material 9 that is transported by two pairs of capstan rollers 12, an image is formed with inkjet recording unit 2 that is driven by the data divided into suitable pixels and gradation levels by the calculation with image data processing and control unit 21. Near the position where image recording is made with inkjet recording unit 2, it is desirable to locate earth terminal 13 to the counter electrode for the ink-ejecting electrode in order to facilitate the ejection caused by an electrostatic field. On the other hand, when the base material of the plate is highly electrically insulating, an electro-conductive layer should preferably be provided

on the base, in which case an earth terminal is preferably provided on the conductive layer by means of a brush, a board spring or a roller, each made of conductive materials.

Though Figs. 2 and 14 each illustrates an apparatus using sheet-formed plate materials, roll-type ones can also be used in which a sheet cutter is preferably equipped at the upstream of the automatic plate unloader.

Plate making apparatuses 1A and 1B also have fixing unit 5 that acts to enhance the durability of the oil-based ink image formed on plate material 9. And, depending on the application purpose, desensitization unit 6 may also be equipped that improves the hydrophilic nature of the plate surface. Plate making apparatuses 1A and 1B furthermore have dust-removing member 10 that removes dust present on the plate material surface prior to or during recording. With such members, a high quality recording can be performed by preventing undesirable ink deposition conveyed via the surface of dust lying between the head and the plate during recording. Dust can be removed by any method known in the art including non-contact ones such as blow-off and electrostatic removing, and contact ones using a brush or a roller. Among them, the most preferable method is air suction or air blow. These methods can be applied separately or in combination.

Plate making apparatuses 1A and 1B may further have automatic plate loader 7 that automatically loads plate material 9, automatic plate unloader 8 that removes plate 9 when image recording has finished. The advantageous features of the invention can be enhanced with the use of automatic plate loader 7 and automatic plate unloader 8 because the printing operations become easy and the turnaround time is shortened.

Referring to Figs. 2 and 14 and partially to Fig. 3, the plate making using apparatuses 1A and 1B will be explained in more detail below.

First, plate material 9 is transferred with use of automatic plate loader 7 and capstan rollers 12. When necessary, a plate guide not shown in the figure may also be equipped to prevent the leading or trailing edge of the plate material from flapping and thus from damaging inkjet recording unit 2 by its accidental contact with the unit. Alternatively, a similarly desirable condition can be realized by keeping the plate material never to loosen only at a limited area including the recording position of the inkjet recording unit. Practically, for example, plate-suppressing rollers may be arranged at the upstream and downstream sides of the recording position. Further, the head when not working should be separated from plate

material 9 to effectively prevent the damage of inkjet recording unit 2.

Image data from magnetic disk devices are sent to image data processing and control unit 21, which calculates ink ejecting positions and the area coverage at each position based on the input image data. These calculated data are once stored in a buffer memory.

Image data processing and control unit 21 controls the movement of ejecting head 22, the timing of oil-based ink ejection, the operating timing of the capstan rollers, and when necessary, moves ejecting head 22 to a position close to plate material 9 with the use of head distancing/approximating unit 31.

The spacing between head 22 and the surface of plate material 9 is kept at a pre-determined value during recording by a mechanical means such as a knocking roller, or by controlling the motion of the head distancing/approximating unit with the signal from an optical spacing detector. Owing to such a spacing control, the recorded dot size would not fluctuate even when the plate floats or when a vibrating force is applied to the plate making apparatus.

Ejecting head 22 may be of single-channel type, multi-channel type, or of full line head type, and sub-scanning is carried out by conveying plate material 9. In

cases where the head is of multi-channel type having plural ejecting points, those points are arranged in a direction substantially perpendicular to the conveyance direction of the plate material. In the case of single-channel or multi-channel head, head 22 is moved perpendicular to the plate transport direction together with each plate movement by image data processing and control unit 21, and the ink is ejected onto plate material 9 by the amounts corresponding to the calculated positions and area coverage values. In this manner, a halftone image comprising the oil-based ink and reproducing the density distribution of the original is formed on plate material 9. Such an operation continues until an ink image corresponding to a single color for the original completes. On the other hand, in the case of a full line width head, the line of the ejecting points is arranged substantially perpendicular to the plate transport direction, and when the entire area of plate material 9 passes the recording line, the formation of a single color image for the original completes.

Ejecting head 22 is driven to retreat away from the position close to plate material 9 for recording. The head distancing/approximating member acts to separate the recording head at least by 500 μm from plate material 9 when the head is not operating. Such a separating action

may be performed with a sliding mechanism, or with an arm fixed to a certain axis and rotating the arm around the axis to cause a pendulum-like movement of the head. With such a head retreat in its suspended period, the inkjet head is protected from physical damage or contamination, thus operating for a long life.

The mechanical durability of the oil-based ink image thus formed is improved with fixing unit 5. Image fixing can be performed by various methods known in the art such as heat or solvent fixation. For heat fixation, irradiation with an infrared lamp, a halogen lamp or a xenon flash lamp, heated air fixing or heat roll fixing can be adopted. Flash fixing with a xenon lamp, well known as a fixing method for electrophotographic toner, has an advantage of a very short fixing time. When the base of the plate is made of paper, a rapid temperature rise promotes an abrupt moisture vaporization to cause blisters in the plate surface. To avert blister formati the temperature of such a paper-based plate material should preferably be raised gradually by arranging multiple fixing unit along the plate path whereby the distance from each member to the surface and/or the power supplied to each member is appropriately adjusted.

In solvent fixation, a solvent such as methanol and ethyl acetate that can dissolve the resinous

ingredient in the ink is brought into contact with the plate in the form of spray mist or vapor, and the excessive vapor is collected.

It is desirable to keep the oil-based image formed on plate material 9 not brought into contact with anything after the image formation with ejecting head 22 and at least until the image is fixed with fixing unit 5.

The plate thus prepared is subjected to the conventional lithographic printing; i.e., plate 9 holding the oil-based ink image is loaded on a printer, supplied with a printing ink and dampening water to give rise to a printing ink image, which is first transferred onto a blanket cylinder rotating with a plate cylinder, and then further from the blanket cylinder to a sheet of printing paper passing between the blanket cylinder and an impression cylinder. In this way, printing of one color finishes. With the end of printing, the blanket held on the blanket cylinder 12 is washed with a blanket-washing device to be made ready for next printing.

Inkjet recording unit 2 will be described in detail.

As is illustrated in Fig. 3, inkjet recording unit 2 used for plate making consists of ink ejecting head 22 and ink feeding unit 24. Ink feeding unit 24 consists of ink tank 25, ink feeder 26 and ink concentration controller 29. Inside ink tank 25 is equipped stirring member 27 and ink

temperature control member 28. Ink may be circulated in ejecting head 22 whereby ink-feeding unit 24 has the functions of collection and circulation. Stirring member 27 suppresses the precipitation or aggregation of the solid ingredients in the ink, thus reducing the frequency of cleaning ink tank 25. Such an stirring member includes a rotating blade, an ultrasonic oscillator and a circulation pump, which can be used individually or in combination. Ink temperature control member 28 is needed to secure the consistency of the recorded image quality by keeping the physical properties of the ink almost constant and thus by suppressing dot size fluctuation. Temperature control can be carried out by any known method, for example, by providing ink tank 25 with a heat-generating or absorbing element such as heater or Peltier element together with stirring member 27 that averages the temperature distribution inside the tank and a temperature sensor such as thermostat. The temperature of the ink kept in tank 25 should preferably be kept between 15°C and 60°C, and more preferably between 20°C and 50°C. The stirring member for temperature distribution averaging may be also used to prevent the precipitation or aggregation of the solid ingredients in the ink.

Moreover, to output high quality images, the present plate making apparatus should preferably be provided with

ink concentration control member 29. When the solid content of the ink drops, the resulting image tends to spread laterally on the plate or becomes unclear while the rise-up of ink concentration causes the dot size to fluctuate. Such drawbacks can be effectively prevented by control member 29. The concentration of ink is monitored optically, by measuring its physical properties such as electro-conductivity or viscosity, or by the number of recorded plates. In the case where physical property measurements are made, an optical detector, a conductivity or viscosity sensor is installed in tank 25 or along the ink flow path alone or in combination, and the output signals from those measuring devices are used for the replenishment of an undiluted ink or an ink diluent from a corresponding reservoir, (both not shown in the figure) to the ink tank. In the management based on the recorded plate number, a similar replenishment is made according to the integrated number of recorded plates or the frequency of recording.

In addition to the processing of input image data or the motion control of the head using head distancing/approximating unit 31 or head sub-scanning member 32, image data processing and control unit 21 shifts the head according to the timing pulse from encoder

30 provided on drum 11 or on the capstan rollers whereby the positional accuracy is improved.

The plate making apparatus 1B according to the second aspect of the invention is equipped with an anomaly detecting member to detect anomalies that interfere image formation; in the following, such detector 100 will be described in detail with reference to Fig. 15 and Fig. 16.

Detector 100 acts to detect the deposition of foreign matters on the ejecting head, or to detect dust or vibration. As for the deposition of foreign matters on the ejecting head, the detector monitors abnormal currents to the head, image defects, or the anomalies in the meniscus form. When the detector finds such symptoms, it orders to suspend the image formation operation and/or activates a cleaning member for the ejecting head. As for the cleaning member, descriptions will be given later.

As an example, when dust adheres the ejecting head 22 as shown in Fig. 15, the discharge spacing becomes short or is short-circuited causing an abnormally larger current than the normal one to flow. Therefore, current detecting circuit 111 is provided to measure the current i to the ejecting head, and the electric signal therefrom is converted to a digital signal by signal processing circuit 112, which is sent to CPU 110. CPU 110 compares the received digital signal with the reference value stored in

memory 113, and activates recording suspension member 117 and/or cleaning member 118 when the result of comparison tells that the current is outside the allowance limit.

To detect anomalies on the meniscus shape, meniscus M formed by the capillary effect between ejecting head 22 and the inkjet ink is photographed with a CCD camera 1141, and the recorded image is subjected to an automatic shape analysis via image processing circuit 115 and CPU 110. The resulting shape characteristics are compared with those of the reference meniscus stored in memory 113 by CPU 110. When there is no dust deposition on ejecting head 22, the photographed shape is equal to that of the reference meniscus. However, with some dust deposition on head 22, CCD camera 1141 depicts some shape deformation. When the comparison by CPU 110 judges that the degree of deformation is beyond the pre-determined allowance limit, then CPU 110 activates image recording suspending member 117 and/or cleaning member 118.

The procedure for detecting image defects is basically the same as that for detecting meniscus anomalies; i.e., a CCD camera 1142 takes in recorded image G formed by ink ejection, and image processing circuit 115 converts the taken image to digital signals and sends them to CPU 110, which compares these signals with those of the reference image data stored in memory 113. When the

comparison by CPU 110 judges that the degree of difference is beyond the pre-determined allowance limit, then CPU 110 activates image recording suspending member 117 and/or cleaning member 118.

When the suspended time of the recording unit is too long, the cleaning member is also operated appropriately.

Dust detection is carried out on those lying on the plate material or floating in the apparatus. Optical detection or the weight measurement of the dust collected in a filter can be used for the present purpose, but optical detection is preferred.

As is depicted in Fig. 16, plural pairs of a light emitting device and a photoelectric sensor, 1221-1231 and 1222-1232 are arranged on the plate material A and at a place that tends to attract dust B. Light emitting devices 1221 and 1222 comprise LED connected to LED driver 121. This driver 121 makes LEDs 1221 and 1222 emit light according to the control of CPU 120. On the other hand, photoelectric sensors 1231 and 1232 are phototransistors each connected to photoelectric converter circuit 1241 or 1242. When photoelectric device 1231 or 1232 receives the light emitted by 1221 or 1222, then photoelectric converter circuit 1241 or 1242 converts the light energy to electric signals and output them to signal processing circuit 125. The signal processing circuit 125 converts

the electric signals to digital signals and output them to CPU 120. CPU 120 compares the received digital signals with the reference values stored in memory 126. When the comparison judges that the degree of deviation is beyond the pre-determined allowance limit, then CPU 120 activates image recording suspending member 127 and/or cleaning member 128.

Next, ink-ejecting head 22 is described in detail with reference to Fig. 4 to Fig. 10, not to limit the scope of the invention.

Fig. 4 and Fig. 5 depicts an example of ink-ejecting head 22 equipped in the present inkjet recording unit. Head 22 has ink-ejecting slit 22a formed with upper unit 221 and lower unit 222, both made of an insulator; inside the slit, ejecting electrode 22b is installed, and the interior space of the head is filled with ink 23 fed by an ink feeder. Insulators used for the upper and lower units include plastic, glass or ceramic. Ejecting electrode 22b can be formed via various methods well known in the art; typically, on lower unit 222 comprising an insulator is formed a conductive layer consisting of aluminum, nickel, chromium, gold or platinum by vacuum deposition, spattering or electroless plating, then on the layer a photo-resist coating is made, which is exposed through a mask having a pre-determined electrode pattern followed by

development to give a photo-resist pattern of ejecting electrode 22b, and finally etching or mechanical removal is performed. Each of the known methods may be adopted solely or in combination with each other.

To ejecting electrode 22b of inkjet head 22 is applied a potential modulated by the digital signal representing an image pattern. As is shown in Fig. 4, drum 11 is arranged so as to face and act as the counter electrode to 22b, and plate material 9 is placed on drum 11. By applying a potential, an electric circuit is formed with electrode 22b and counter electrode (= drum) 11, thus causing oil-based ink 23 to eject from ejecting slit 22b of head 22 toward plate material 9 placed on drum 11 and resulting in image formation on plate material 9.

The width of electrode 22b should be as small as possible for high quality image formation. A preferable range, which depends on applied voltage and/or ink properties, is usually from 5 to 100 μm.

A practical example for the combination of the parameters involved is as follows; with the tip of ejecting electrode 22b of 20 μm width, the distance between electrode 22b and drum (=counter electrode) 11 being 1.0 mm, and by applying 3 kV between the two electrode for 1 msec, a 40 mm diameter dot can be formed on plate material 9.

In Fig. 6 and Fig. 7, each depicts schematically the cross-sectional or the front view of another ejecting head, respectively. Ejecting head 22 has a first insulating wall 33 with a tapered cross-section. A second insulating wall 34 faces this first wall 33 with an intervening space, and the forefront tip end of 34 is inclined to form a slanted end portion 35. Those walls are made of, for example, plastic, glass or ceramic. On the upper plane 36 of the second wall that forms an acute angle with the slant portion 35 of the second insulating wall 34, plural ejecting electrodes 22b are provided as the means of forming an electrostatic field at the ejecting position. The forefront end of each electrode 22b extends to the end of the upper plane 36, and protrudes beyond the end of the first insulating wall 33, thus forming an ink ejecting point. The space between the first and second insulating walls 33 and 34 makes ink flow path 37 through which the ink is fed to the ejecting point. On the second insulating wall 34 is formed an ink collecting path 38. The ejecting electrodes 22b are formed by any conventional method well known in the art using a conductive material such as aluminum, nickel, chromium gold or platinum. Each electrode 22b is electrically insulated from each other.

The length by which the tip end of ejecting electrode 22b protrudes beyond the end of wall 33 should

not exceed 2 mm. When this length is too large, the ink meniscus will not reach the tip end of the ejecting electrode and fails to eject, or the recording frequency drops. The space between walls 33 and 34 should be 00.1 to 3 mm. Narrower spaces than this range make ink feed difficult, and also cause the drop of recording frequency. On the other hand, broader spaces make the ink meniscus unstable, causing ink ejection inconsistent.

Image data processing and control unit 21 controls the potential of ejecting electrode 22b according to image data, and electrode 22b ejects ink onto the plate material (not shown in the figure) arranged to face the ejecting point of the electrode. The left-side end of ink flow path 37 is connected to the feeding member of an ink feeder not shown in the figure. Below the second insulating wall 34, backing 39 is provided parallel to 34 with an intervening spacing. The spacing in-between forms ink-collecting path 38. This spacing should preferably be not narrower than 0.1 mm from the viewpoint of the difficulty of ink collection as well as the prevention of ink leakage. Ink collecting path is connected to an ink recovering member of an ink feeder not shown in the figure.

In the case where a uniform ink flow on the ejecting point is needed, thin dents 40 may be formed between the ejecting point and the ink-collecting path. Fig. 7

schematically illustrates the front view of the ink ejecting point, in which the inclined front end of insulating wall 34 has a plurality of grooves 40 running from the boundary with electrode 22b to ink collecting path 38. Such dents attract a certain amount of ink in the neighborhood of the aperture of electrode 22b by capillary force towards ink-collecting path 38. Owing to this discharging action of the dents, an ink layer of a constant and uniform thickness can be formed near the end of the ejecting electrode. The shape and size of dents 40, which are designed so as to exert a sufficient capillary force, should preferably be 10 to 200 μm wide and 10 to 300 μm deep. It should be noted that dents 40 must be provided over the entire width of the ejecting head with a purpose of forming a uniform ink flow.

The tip end width of ejecting electrode 22b should be as short as possible for the formation of high-resolution images. Practically, the tip end width of from 5 to 100 μm is preferred, though the optimum value depends on applied voltage and/or ink properties.

Some other examples of the ejecting head used in the invention are illustrated in Fig. 8 and Fig. 9. Fig. 8 depicts schematically a part of such a head. Head 22 consists of head body 41 made of an insulating material such as plastic, ceramic or glass and meniscus regulating

plates 42 and 42'. A voltage is applied to ejecting electrode 22b to form an electrostatic field at the ejecting point. A more detailed description of the head body will be made with reference to Fig. 9 in which meniscus regulating plates 42 and 42' are removed.

Perpendicularly to the edge of head body 41, plural ink dents 43 are provided for ink circulation. The shape and size of dents 43, which are designed so as to achieve a uniform ink flow by capillary force, should preferably be 10 to 200 μm wide and 10 to 300 μm deep. Inside dents 43 are provided ejecting electrodes 22b. These electrodes can be formed on head body 40 made of an insulating material with the use of an electro-conductive material such as aluminum, nickel, chromium, gold or platinum to cover the surface of dents 43 entirely or partly. The concrete method of electrode formation has been already given in the description of Fig. 4 and Fig. 5. Each ejecting electrode is isolated from each other. Contiguous two dents form a single cell. At the tip of dividing wall 44 located at the center of the cell are provided ejecting points 45 and 45'. At these ejecting points 45 and 45', the dividing wall is fabricated thinner than the remaining area of 44, thus forming sharp edges. Such a structure of the head body can be made by any method known in the art including mechanical processing,

etching or molding a block of the insulating material. The thickness of the dividing wall should preferably be 5 to 100 μm, and the diameter of curvature at the sharpened edge should preferably be in the range of 5 to 50 μm. The corner of the point may be slightly beveled as 45′ shown in the figure. The figure depicts only two cells, and the cells are separated with dividing wall 46, and its tip 47 is beveled in such a manner that tip 47 stands back relative to ejecting points 45 and 45′. An ink feeding member of an ink feeder not shown in the figure supplies ink to the ejecting point via the ink dents from the direction designated by I. Further, excessive ink is collected by an ink recovering member not shown in the figure to the direction designated by O. Thus, the ejecting point is always fed with fresh ink. By using such a configuration under such an operating condition described above, ink is ejected from the ejecting head to a plate material held on a drum (not shown in the figure) by the application of signal voltage modulated by image data to the ejecting electrode.

Still another example of the ejecting head is described with the help of Fig. 10. Ejecting head 22 has supporting members 50 and 50′ made of substantially rectangular boards of plastic, glass or ceramic with a 1 to 10 mm thickness. On one side of each board are formed

plural dents 51 and 51′ parallel to each other. The spacing of the dents is determined by the image resolution to be recorded. Each groove 51 or 51′ should preferably be 10 to 200 μm wide and 10 to 300 μm deep. In each groove, ejecting electrode 22b is formed that covers the surface of the groove entirely or partly. By forming plural dents 51 and 51′ on one surface of supporting members 50 and 50′, plural dividing walls 52 result between each groove 51. Supporting members 50 and 50′ are bonded together at the surfaces opposite to the ones on which the dents were formed. As a result, on its outer surface, ejecting head 22 has dents 51 and 51′ through which ink flows. Upper groove 51 is connected to lower groove 51′ via rectangular end 54 of ejecting head 33, and rectangular end 54 stands back relative to upper end 53 of ejecting head 22 by a pre-determined distance of about 50 to 500 μm. In other words, on both sides of each rectangular end 54, there is provided upper end 55 of each dividing wall 52 of each supporting member 50 and 50′. And, from each rectangular end 54, guiding part 56 made of an insulating material described previously protrudes to form an ejecting point.

In order to circulate ink to ejecting head 22 thus constructed, ink is fed to rectangular end 54 through each groove 51 provided on the outer surface of supporting

member 50, and driven out via each lower groove 51′ formed in the opposite surface of lower supporting member 50′. To facilitate a smooth ink flow, ejecting head 22 is slanted by a pre-determined angle so that the feeding side (supporting member 50) be located upward relative to the discharge side (supporting member 50′). When ink is circulated in such an arrangement, ink passing each rectangular end 54 wets each projection 56 and forms an ink meniscus near rectangular end 54 and projection 56. Facing to the menisci thus formed independently on all projections, a drum holding a plate material thereon is arranged (not shown in the figure). An electric field is formed between the drum and ejecting electrode 22b modulated by image data to cause the ink to eject for image formation. Alternatively, ink can be compulsorily circulated by forming a cover sealing the dents formed on the outer surfaces of supporting members 50 and 50′, thus forming an ink flow pipe. In this construction, ejecting head 22 need not be inclined.

In the first aspect of the present invention, each ejecting head 22 depicted in Fig. 4 to Fig. 10 is provided with cleaning member 60 of the invention shown in Fig. 11. Ejecting head 22 is moved to this cleaning member 60 with a head transport member not shown in the figure, and then at least the ink ejecting tip of head 22 is immersed in

cleaning liquid 57, and the ejecting electrode of head 22 is applied with a potential the polarity of which is equal to that of the charged solid ingredient in the ink via conductive wire 591 from voltage source 59 whereby another wire 592 from source 59 is connected to the metal chassis of cleaning liquid tank 58. Then, the charged solid ingredient is vigorously repelled from the ejecting electrode leaving a clean electrode.

The potential to be applied may be AC or DC superimposed with an AC whereby the polarity of the DC component is equal to that of the charged particles in the ink. Particularly desirable cleaning effects are obtained with the latter type of potential that causes the solid ingredient to vibrate, thus facilitating cleaning.

Further, simultaneous application of ultrasonic wave improves cleaning effect. Suitable cleaning liquids that must be chemically inactive to the ejecting head include alcohols, the ink solvent or the ink itself.

Fig. 12 is a flow chart describing the working mechanism of cleaning member 60. Cleaning member 60 works when the recording unit is suspended for a prolonged period or when some problems take place as for the quality of recorded images. A suspension time counter not shown in the chart monitors the operating condition of the printing unit, and when suspension lasts for a pre-

determined period (for example, one month) (Step 1), cleaning member 60 begins to work (Step 3)

On the other hand, the image quality of recorded images is always monitored, for example, with a CCD camera and by comparing the monitored one with a reference image stored in a memory. When a serious problem in the image quality of the recorded image is found by such a comparison (Step 2) even when the suspension time is shorter than the pre-determined one, cleaning member 60 starts to work (Step 3).

When cleaning member 60 starts to work, at least the tip of electing head 22 is immersed in cleaning liquid 57 for cleaning as is depicted in Fig. 11.

After cleaning, the suspension time counter for the printer is reset to start counting of the suspension time of the recording unit.

The head cleaning method described above is better than other methods as the cleaning effect is high with simple operations. Such inferior other methods include, for example, wiping the tip of the ink-ejecting head with a soft brush or cloth, circulation of a pure solvent of the ink together with or without suction of the head, compulsory ink suction from the ejecting end, compulsory injection of an ink solvent or air from the ink flow path. Additionally, to prevent ink solidification, it is

effective to cool the head, thus suppressing the vaporization of the ink solvent.

Also in the second aspect of the present invention, each ejecting head 22 depicted in Fig. 4 to Fig. 10 may comprises a maintenance device such as a cleaning member if needed. For example, when a suspension period continues or an image quality problem has been caused, good imaging quality can be maintained by using the means of wiping the tip of ink-ejecting head with a soft brush or cloth, circulating only an ink solvent, or sucking the ink-ejecting parts with feeding or circulating only an ink solvent, either alone or in combination. Further, for preventing ink solidification, it is effective to cool the head, thus suppressing the vaporization of the ink solvent. When staining is heavy, it is also effective to forcedly suck the ink from the ink-ejecting part, forcedly introduce air, ink or the jet of an ink solvent from the ink channel, or apply ultrasonic wave with immersing the head in an ink solvent, and these methods may be used either alone or in combination.

Now, the plate materials for use in the invention will be described below.

Metal plates comprising aluminum or chromium-plated steel are preferred. Particularly, aluminum plates having a high water-receptive and wear resistant surface formed

by sandblasting and/or anodic oxidation are preferred. More economical materials include those comprising a superficial image-receiving layer provided on a water-resistant substrate including water-resistant paper, plastic films or paper/plastic film laminates. A preferable thickness range for such materials is 100 to 300 µm whereas the image-receiving layer preferably has a thickness of 5 to 30 µm.

Preferable examples of such image-receiving layers include hydrophilic layers comprising inorganic pigments and a binder, or those that can be converted hydrophilic via a suitable desensitizing treatment.

Inorganic pigments used in the hydrophilic image-receiving layer include clay, silica, calcium carbonate, zinc oxide, aluminum oxide and barium sulfate. Suitable binder materials include hydrophilic compounds such as poly(vinyl alcohol), starch, carboxymethyl cellulose, hydroxyethyl cellulose, casein, gelatin, polyacrylic acid salts, poly(vinylpyrolidone) and methyl ether-maleic anhydride copolymer. In the case where certain levels of water resistance are needed, cross-linking agents such as melamine-formaldehyde resin or urea-formaldehyde resin may be incorporated.

On the other hand, layers comprising zinc oxide dispersed in a hydrophobic binder represent image receiving ones used with a desensitizing treatment.

Any type of zinc oxide that is commercially available as zinc white, wet process zinc white or active zinc white can be used in the invention. As for zinc oxide, reference is made to p. 319 of "Shinpan Ganryo Binran" (Pigment Handbook, a New Edition) edited by Pigment Technology Association of Japan and published by Seibundo Publishing Co. in 1968.

Zinc oxide is classified according to its raw material and manufacturing process; dry procedures include French (indirect) and American (direct) processes, and wet processes are also employed. Representative manufacturers include, for example, Seido Chemical Co., Sakai Chemical Co., Hakusui Chemical Co., Honjo Chemical Co., Toho Zinc Co., and Mitsui Metal Industries Co.

Resinous materials used for the binder of the zinc oxide layer include styrene copolymers, methacrylate copolymers, acrylate copolymers, vinyl acetate copolymers, poly(vinyl butyral), alkyd resins, epoxy resins, epoxy ester resins, polyester resins and polyurethane resins. Each of those may be used alone or in combination.

The content of the resin binder in the image-receiving layer preferably lies between 9/91 and 20/80 in terms of binder/zinc oxide weight % ratio.

Such a zinc oxide layer is desensitized by the treatment with a desensitizing solution well known in the art. Suitable desensitizing solutions include cyanide-containing ones comprising ferrocyanide or ferricyanide salts, cyanide-free ones comprising amine cobalt complexes, phytic acid and its derivatives or guanidine derivatives, those comprising inorganic or organic acids capable of forming a chelate with zinc ion, or those containing water-soluble polymers.

Cyanide-containing solutions are disclosed in, for example, JP-B-44-9045 (The term "JP-B" used herein means an "examined Japanese patent publication") JP-B-46-39403, JP-A-52-76101, JP-A-57-107889 and JP-A-54-117201.

The back surface opposite to the image-receiving layer of the plate material should have a Beck smoothness of 150 to 700 (sec/10mL). With such a back surface, the plate will not slip or shifts on the plate cylinder, thus enabling a highly precise printing.

Beck smoothness can be measured with a Beck smoothness tester; a test piece is pressed against a circular hole provided at the center of a glass plate having an extremely smooth surface at a pre-determined

pressure (1kgf/cm^2 or 9.8N/cm^2), and the time required for a fixed volume (10mL) of air to leak between the glass plate and the test piece under a reduced pressure is measured.

The oil-based ink used in the invention will be explained in the following.

The oil-based ink used in the invention consists of a non-aqueous solvent that has a specific resistance not lower than 10^9 Ωcm and a dielectric constant not exceeding 3.5, and a hydrophobic particulate resin dispersed in the solvent, the resin being solid at least at room temperature.

Such non-aqueous solvents with a specific resistance not lower than 10^9 Ωcm and a dielectric constant not exceeding 3.5 and preferably used in the invention include straight or branched chain aliphatic hydrocarbons, alicyclic hydrocarbons, aromatic hydrocarbons, and halogen substituted derivatives of these hydrocarbons. Some examples are hexane, heptane, octane, isooctane, decane, isodecane, decaline, nonane, dodecane, indodecane, cyclohexane, cyclooctane, cyclodecane, benzene, toluene, xylene, mesitylene, Isopar C, Isopar E, Isopar G, Isopar H, Isopar L (Isopar is a trade name of EXXON Co.), Shellsol 70, Shellsol 71 (Shellsol is a trade name of Shell Oil Co.), Amsco OMS, Amsco 460 solvent (Amsco is a trade name

of Spirits Co.) and silicone oil. They are used individually or as mixtures. The upper limit of the specific resistance of these non-aqueous solvents is about 10^{16} Ωcm, and that of the dielectric constants is about 1.9.

When the resistance of the non-aqueous solvent used in the invention is below the lower limit of the preferable range mentioned above, the resinous particles will not be concentrated, resulting in output images with a poor wear resistance while, when the dielectric constant exceeds the upper limit of the preferable range mentioned above, a too much relaxation of electric field takes place due to the polarization of the solvent, deteriorating the consistency of ink ejection.

The particulate resin (P) dispersed in the non-aqueous solvent described above should preferably be solid at temperatures not exceeding 35°C, and have a sufficient affinity to non-aqueous solvents. Moreover, those having a glass transition temperature (Tg) ranging from -5°C to 110°C, or a softening point ranging from 33°C to 140°C are desirable. More preferably, those with a Tg between 10°C and 100°C, or with a softening point between 38°C and 120°C are used. Still more preferably, Tg should be from 15°C to 80°C, or the softening point from 38°C to 100°C.

By using such resins satisfying the conditions for Tg or softening point, the affinity between the surface of

the image-receiving layer of the plate and the particulate resin is sufficiently intense, and at the same time, the binding force among the resin particles is large. Therefore, the adhesion between the image and the image-receiving layer and thus the print durability of the plate are enough. With resins with Tg's or softening points outside the preferred range cited above, the affinity between the image-receiving layer and the particulate resin is not enough, or the binding strength among the resin particles is insufficiently weak.

The weight-averaged molecular weight Mw of resin P should be 1×10^3 to 1×10^6, preferably 5×10^3 to 8×10^5 and more preferably 1×10^4 to 5×10^5.

Practical examples for resin P include olefin polymers and copolymers such as, for example, polyethylene, polypropyrene, polyisobutyrene, ethylene-vinyl acetate copolymers, ethylene-acrylate copolymers, ethylene-methacrylate copolymers, and ethylene-methacrylic acid copolymers, vinyl chloride polymers and copolymers such as poly(vinyl chloride) and vinyl chloride-vinyl acetate copolymers, vinylidene chloride copolymers, polymers and copolymers of vinyl esters of alkanoic acid, polymers and copolymers of allyl esters of alkanoic acid, polymers and copolymers of styrene or styrene derivatives such as, for example, butadiene-styrene copolymers, isoprene-styrene

copolymers, styrene-methacrylate copolymers and styrene-acrylate copolymers, acrylonitrile copolymers, methacrylonitrile copolymers, alkyl vinyl ether copolymers, polymers and copolymers of acrylic acid esters, polymers and copolymers of methacrylic acid esters, polymers and copolymers of itaconic acid diesters, maleic acid copolymers, acrylamide copolymers, methacrylamide copolymers, phenol resins, alkyd resins, polycarbonate resins, ketone resins, polyester resins, silicone resins, amide resins, hydroxy and carboxy group-modified polyester resins, butyral resins, poly(vinyl acetal) resins, urethane resins, rosin-based resins, hydrogenated rosin-based resins, petroleum resins, hydrogenated petroleum resins, maleic acid resins, terpene resins, hydrogenated terpene resins, coumarone-indene resins, cyclized rubber-methacrylate copolymers, cyclized rubber-acrylate copolymers, copolymers containing nitrogen-free heterocyclic rings (examples of such rings being furan, tetrahydrofuran, thiophene, dioxane, dioxofuran, lactone, benzofuran, benzothiophene and 1,3-dioxetane) and epoxy resins.

The content of the resin dispersed in the oil-based ink of the invention should preferably be 0.5 to 20% by weight based on the total ink quantity. Contents below the cited range tend to cause various problems such as a

poor wear resistance of the recorded image due to a poor affinity between the ink and the plate surface, while, with those exceeding the cited range, homogeneous dispersion becomes difficult or the ejecting head tends to choke, hindering a consistent ink ejection.

In addition to the dispersed resin particles described above, the oil-based ink used in the invention can contain a coloring agent that makes visual plate check easy after plate making. As preferable examples of such coloring agents, pigments or dyestuffs that have been conventionally used in various ink formulations or liquid toners for electrophotography are included.

Inorganic or organic pigments that have been widely used in graphic arts can be applied to the present purpose, including, for example, carbon black, cadmium red, molybdenum red, chrome yellow, cadmium yellow, titanium yellow, chromium oxide, viridian, cobalt green, ultramarine blue, Prussian blue, cobalt blue, azo pigments, phthalocyanines, quinacrydones, isoindolinones, dioxazines, indanthrenes, perylenes, perynones, thioindigo pigments, quinophthalone pigments, metal complex pigments, and still other ones known in the art.

Suitable dyestuffs include azo dyes, metal complex salt dyes, naphthol dyes, anthraquinone dyes, indigo dyes, carbonium dyes, quinonimine dyes, xanthene dyes, aniline

dyes, quinoline dyes, nitro dyes, nitroso dyes, benzoquinone dyes, naphthoquinone dyes, phthalocyanine dyes and metal phthalocyanine dyes.

Each of these pigments and dyestuffs can be used individually or in combination. A preferable range of the content is from 0.01 to 5% by weight of the entire ink quantity.

These coloring agents may be dispersed in the non-aqueous solvent separately from the dispersed particulate resin, or incorporated in the particulate resin. In the latter case, pigments are often coated with resinous materials, and dyestuffs are used to dye the surface of the dispersed particles.

The average particle size of the particulate resin and the particle of coloring agents dispersed in the non-aqueous solvent should preferably be 0.05 to 5 μm, and more preferably 0.1 to 1.0 μm. These particle size values were determined with CAPA-500 manufactured by Horiba Manufacturing Co.

The particulate resin dispersed in the non-aqueous solvents used in the invention can be prepared by conventional mechanical grinding or particle-forming polymerization processes known in the art. As a typical mechanical method, all the ingredients for the particulate resin are mixed, melted and then blended, followed by

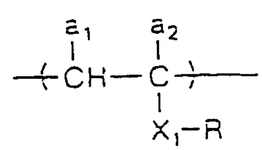
direct grinding with a grinder; the obtained fine particles together with a polymer dispersant are further dispersed with a wet-type dispersing machine (e.g., ball mill, paint shaker, KD mill or Dyno mill). Another method consists of first preparing a mixture comprising all the ingredients for the particulate resin and an auxiliary polymer dispersant (or a polymer for coating), then finely dividing the mixture and finally dispersing the finely divided resin in the presence of a polymer dispersant. Suitable methods include those for the preparation of paint or electrophotographic liquid toner, and detailed descriptions on those are found in, for example, "Paint Flow and Pigment Dispersion", supervised and translated by Kenji Ueki (Kyoritsu Shuppan Publishers Co., 1971), "Paint Science" by Solomon (Hirokawa Shoten Co., 1969) and "Coating Engineering" (Asakura Shoten, 1971) and "Basic Science of Coating" (Maki Shoten, 1977), both authored by Yuji Harasaki.

As particle-forming polymerization methods, dispersion polymerization in non-aqueous systems is well known. Practical descriptions are found in Chapter 2 of "Recent Technologies of Ultra-fine Polymers", supervised by Souichi Muroi (CMC Shuppan, 1991), Chapter 3 of "Recent Electrophotographic Developing System and Development of Toner Materials" by Koichi Nakamura (Nihon Kagaku Joho Co.,

1985) and "Dispersion Polymerization in Organic Media" by K. E. J. Barrett (John Wiley, 1975).

Usually, in order to stably disperse a particulate resin in a non-aqueous solvent, a polymer dispersant is used. Such a polymer dispersant consists, as its principal component, of a recurring unit that is soluble in the non-aqueous solvent preferably having a weight-averaged molecular weight Mw of from 1×10^3 to 1×10^6, more preferably from 5×10^3 to 5×10^5.

Some preferable examples for such a recurring unit for the polymer dispersant include those expressed by the following general formula (I).



(I)

In General formula (I), X_1 represents -COO-, -OCO- or -O-, R represents an alkyl or alkenyl group of C_{10-32}, more preferably those of C_{10-22}, R having straight- or branched chain. Though those chains may be substituted or unsubstituted, unsubstituted ones are more preferred.

Practical groups include decyl, dodecyl, tridecyl, tetradecyl, hexadecyl, octadecyl, eicosanyl, docosanyl, decenyl, dodecenyl, tridecenyl, hexadecenyl, octadecenyl and linolenyl.

In General formula (I), a_1 and a_2 may be the same or different, representing a hydrogen, atom, a halogen atom such as chlorine or bromine, cyanide, an alkyl group of C_{1-3} such as methyl, ethyl and propyl, $-COO-Z_1$, or $-CH_2COO-Z_1$ (Z_1 represents a hydrocarbon group containing carbon atoms not more than 22 such as alkyl, alkenyl, aralkyl, alicyclic and aryl).

The hydrocarbon groups represented by Z_1 include the following: an alkyl group of C_{1-22} that may be substituted, such as methyl, ethyl, propyl, butyl, hexyl, heptyl, octyl, nonyl, decyl, dodecyl, tridecyl, teteradecy, hexadecyl, octadecyl, eicosanyl, docosanyl, 2-chloroethyl, 2-bromoethyl and 3-bromopropyl, an alkenyl group of C_{4-18} that may be substituted, such as 2-methyl-1-propenyl, 2-butenyl, 2-pentenyl, 3-methyl-2-pentenyl, 1-pentenyl, 1-hexenyl, 2-hexenyl, 4-methyl-2-hexenyl, decenyl, dodecenyl, tridecenyl, hexadecenyl, octadecenyl and linolenyl, an aralkyl group of C_{7-22} that may be substituted, such as benzyl, phenethyl, 3-phenylpropyl, naphthylmethyl, 2-naphthylethyl, chlorobenzyl, bromobenzyl, methylbenzyl, ethylbenzyl, methoxybenzyl, dimethylbenzyl, ethylbenzyl, methoxybenzyl, dimethylbenzyl and dimethoxybenzyl, an alicyclic group of C_{5-8} that may be substituted, such as cyclohexyl, 2-cyclohexylethyl and 2-cyclopentylethyl, and an aromatic group of C_{6-12} that may be substituted, such as

phenyl, naphthyl, tolyl, xylyl, propylphenyl, butylphenyl, octylphenyl, dodecylphenyl, methoxyphenyl, ethoxyphenyl, butoxyphenyl, decyloxyphenyl, chloropheyl, dichlorophenyl, bromophenyl, cyanophenyl, acetylphenyl, methoxycarbonylphenyl, ethoxycarbonylphenyl, butoxycarbonylphenyl, acetamidephenyl, propionamidephenyl and dodecyloylamidophenyl.

Suitable polymer dispersants can have other recurring units copolymerized with those represented by General formula (I). Such copolymerization components may comprise any monomer copolymerizable with the monomers corresponding to the recurring unit in General formula (I).

The ratio of the polymer component represented by General formula (I) to the total quantity of the polymer dispersant should preferably be not less than 50% by weight, and more preferably not less than 60% by weight.

Some practical examples of such a polymer dispersant include the dispersion stabilizing resin Q-1 used in the following example and commercially available products such as Solprene 1205 of Asahi Chemical Co.

The polymer dispersant should preferably be present in the polymerization system for the resin P defined previously as a latex.

The amount of the polymer dispersant added to the system is from 1 to 50% by weight based on the polymer P.

The particulate resin and the coloring particles (or the particles of a coloring agent) should be in the form of charge-detecting particles with a positive or negative polarity.

To impart a charge-detecting capability to such particles, the technologies used for the preparation of electrophotographic liquid toner are preferably employed. Practical descriptions for charge-director are found in p. 139-148 of "Recent Electrophotographic Developing System and Development of Toner Materials" by Koichi Nakamura cited previously, p. 497-505 of "Fundamentals and Applications of Electrophotographic Technologies", edited by The Society of Electrophotography of Japan (Corona Co., 1988) and a literature written by Yuji Harasaki in p. 44 of "Densi-shasin (Electrophotography)", **16**(2), (1977).

Preferable charge-directors are disclosed in, for example, Brit. Patents 893429 and 1122397, US Patents 3900412 and 4606989, JP-A-60-179751, JP-A-60-185963, JP-A-2-13965.

The above described charge directors are preferably added to 1000 parts by weight of carrier liquid by from 0.001 to 1.0 parts by weight. Various additives may be incorporated to the ink formulation. The total amount of such additives is limited by the resistance of the oil-based ink: the specific resistance of the liquid phase

after the dispersed particles have been removed must be higher than 10^9 Ωcm, below which good quality continuous tone images can hardly be obtained.

The present invention will be illustrated in greater detail with reference to the following Examples, but the invention should not be construed as being limited thereto.

EXAMPLES

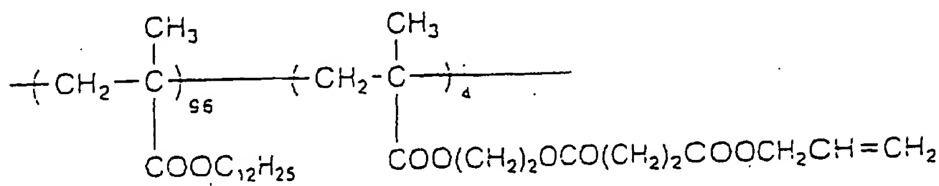
First, an example of manufacturing a particulate resin for inkjet ink (PL) will be given.

Manufacturing Example 1 for Particulate Resin (PL-1):

A mixture consisting of 10g of a polymer dispersant (Q-1) having the following formula, 100g of vinyl acetate and 384g of Isopar H in nitrogen atmosphere was heated to 70°C under stirring. The mixture was then added with 0.8g of 2,2'-azo-bis(isovaleronitrile) (A.I.V.N.) as polymerization initiator, and allowed to react for 3 hours. In 20 minutes after the addition of the initiator, the mixture turned turbid and the temperature rose to 88°C. After the addition of 0.5g of the initiator, the mixture was agitated for 2 hours at 100°C to remove the remaining vinyl acetate. The reaction product was filtered with a 200mesh nylon cloth after cooling to give a monodisperse, stable latex of 0.23 μm average particle diameter with a

polymerization rate of 90%. The particle diameter was measured with CAPA-500, a product of Horiba Manuf. Co., Ltd.

Polymer dispersant (Q-1):



$Mw = 5 \times 10^4$

(Copolymerization ratio is expressed by weight ratio.)

Part of the latex was centrifuged at 1×10^4 r.p.m. for 60min, and the resulting sediment consisting of the polymer particles was collected and dried. The weight-averaged molecular weight (Mw: polystyrene equivalent GPC value) of the polymer was 2×10^5 and its Tg was 38 °C.

EXAMPLE 1A

Preparation of Oil-based Ink (IK-1):

A fine dispersion of nigrosine was prepared by rigorously grinding 10g of a dodecyl methacrylate/acrylic acid copolymer with a copolymerization ratio of 95/5 in terms of weight %, 10g of nigrosine and 30g of Shellsol 71 in a paint shaker (a product of Tokyo Seiki Co., Ltd.) together with glass beads for 4 hours.

An oil-based black ink was prepared by adding 60g (as the solid content) of particulate resin Pl-1 described in Manufacturing example 1, 2.5g of the nigrosine dispersion prepared above, 15g of FOC-1400 (tetradecyl alcohol produced by Nissan Chemical Co., Ltd.) and 0.08g of an octadecene-maleic acid half hexadecylamide copolymer into one liter Isopar G.

Oil-based ink (IK-1) thus prepared was charged by 2 liters in the ink tank of inkjet recording unit 2 in the plate making apparatus 1A (See Fig. 1 and Fig. 3). In this example, a multi-channel type ink ejecting head having 64 channels of 900dpi shown in Fig. 4 was used. By equipping the ink tank with a throw-in heater and stirring blades as an ink temperature control member, the ink temperature was kept at 30°C. The blades were rotated at 30rpm and a thermostat was used to keep the temperature constant. This stirring member was also used to prevent sedimentation or aggregation. A transparent window was equipped along the ink flow path through which a set of a LED device and a light detector monitored the ink concentration. Based on signals from the detector, an ink diluent (Isopar G) or an ink concentrate (having a solid concentration twice as much as that of ink IK-1 described above) was added to the ink for concentration control.

A plate material comprising an 0.12 mm thick aluminum plate the surface of which had been processed with sand blasting followed by anodic oxidation was loaded on the drum of the plate making apparatus by means of plate holders that catch the leading and trailing edges of the plate. After the dust present on the plate surface was removed by air suction with a pump, the ejecting head was brought close to the drum, and image recording was carried out, while rotating the drum, by ejecting the oil-based ink onto the aluminum plate from the moving 64 channel ejecting head which was controlled by the signals from the image data processing and control unit that accepts the data of the original image to be recorded. In the recording, the tip end width of the ejecting electrode was set to 10 µm while the spacing between the head and the plate material was adjusted to 1 mm by using an optical spacing detector. To a bias voltage of 2.5 kV always applied to the ejecting electrode, a 500 V pulse voltage was superimposed for ink ejection whereby the dot area was controlled by changing the voltage pulse duration from 0.2 msec to 0.05 msec in 256 steps. Image deterioration due to dust did not take place at all and the dot area was quite stable under a drifting external atmospheric temperature and with the increase of processed plate number.

Then, a xenon flash fixing device (a product of Ushio Denki Co., having an emission intensity of 200 J/pulse) was used to heat and enforce the image, thus giving a plate for printing. After the plate making, the inkjet recording unit together with the sub-scanning member was retreated away from the recording position close to the drum by 50 mm. The finished plate, after unloaded from the plate making apparatus, was then loaded on the plate cylinder of an Oliver 266 EPZ printer and lithographic printing was performed.

The resulting lithographic prints had sharp and crisp images free of void or blur even after 10,000 runs.

The ejecting head was cleaned after each plate making by being immersed in Isopar G and applied with a positive 1 kV DC for 30 sec. By such a cleaning operation, the head operated perfectly for 6 months without any additional maintenance, consistently making high quality plates for printing.

EXAMPLE 2A

In the apparatus shown in Fig. 2, a 600dpi full line inkjet head of the type shown in Fig. 6 was installed. Ink was circulated by the static pressure difference formed by a pump between two ink reservoirs located in an ink inlet path between the pump and the ejecting head and

between an ink collecting path an ink tank, respectively. The ink temperature was controlled with a heater and the pump for circulation, and kept at 35°C with the aid of a thermostat. This pump for circulation was also used as an stirring member to prevent sedimentation or aggregation. Further, in the ink flow path was arranged an electro-conductivity measuring device, the signals from which were used for ink concentration control by replenishing an ink diluent or concentrate. The above-described aluminum plate used in Example 1A was loaded on the plate making apparatus. After the removal of dust present on the plate surface with a rotating nylon brush, the image data to be reproduced was sent to the image data processing and control unit, and the plate material was run with the capstan rollers. To the moving plate material, the full line head carried out image recording by ejecting ink. An excellent image was formed on the plate accompanied with no image defect due to the presence of dust at all. Also, the dot area was quite stable under a drifting external atmospheric temperature and with the increase of processed plate number. The image was thermally fixed with a heat roller made of silicone rubber sealed with Teflon and installed with a 300W halogen lamp. The roller applied a pressure of $3kgf/cm^2$ ($29.4N/cm^2$) to the image to provide a wear-resistant plate.

The plate thus prepared was used for printing in the same manner as in Example 1A. The obtained lithographic print image was sharp and crisp free of void or blur even after 10,000 runs. The ejecting head was regularly cleaned after every plate making by being immersed in Isopar G under the application of an AC voltage of 0.5kV/1kHz for 40sec. By such a cleaning operation, the head operated perfectly for 6 months without any additional maintenance, consistently making high quality plates for printing.

Similar results were obtained by using another 600 dpi full line inkjet head having a structure shown in Fig. 8 and Fig. 10 instead of the one shown in Fig. 6.

EXAMPLE 3A

Except for the following changes, the same operations as in Example 1A were carried out. Instead of the aluminum plate used in Example 1A, a paper-based plate material was used which had a surface layer to be described shortly and to be converted hydrophilic via a desensitization treatment. The plate material after image formation was subjected to a desensitization treatment with a desensitizing device. By the way, the conductive layer of the plate material was connected to earth during image recording by means of a conductive board spring made

of phosphor bronze. Image fixing was done by blowing hot air to the plate.

Both sides of a premium grade paper having a weight of 100g/m^2 were laminated with a 20 μm thick polyethylene film. The resulting water-resistant substrate was coated with a conductive paint having the following composition on one side in such a manner that the coated amount be 10g/m^2 after drying. On the conductive layer was provided an image-receiving layer having a coating weight of 15g/m^2 on dry base by coating dispersion A.

Conductive paint:

A mixture of the following ingredients.

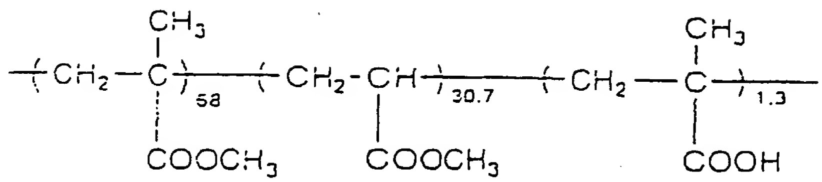
Carbon black (30% aqueous dispersion)	5.4 parts
Clay (50% aqueous dispersion)	54.6 parts
SBR latex (solid content = 50%, Tg = 25°C)	6 parts
Melamine resin (solid content = 80%, Sumilez Resin SR-613)	4 parts
Water to make the solid content equal to 25%	

Dispersion A:

A mixture of 100 g of zinc oxide produced by dry process, 3 g of a binder resin (B-1), 17 g of another binder resin (B-2) each having the following formula, 0.15 g of benzoic acid and 155 g of toluene, prepared with a

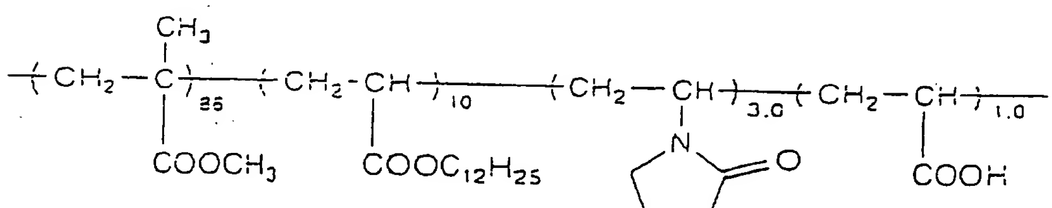
wet-type homogenizer made by Nippon Seiki Co. rotated at 6,000 rpm for 8 min.

Binder resin B-1:



Mw = 9×10^3

Binder resin B-2:



Mw = 4×10^4

(The copolymerization ratios are given by weight.)

As the application of a hot air to the plate caused blistering, fixing was carried out by gradually raising the power supplied to the heater generating the hot air or by decelerating the rotation speed of the drum with a constant power supply. By either method, no blister formed and the finally obtained printed matter was free of void or blur even after 5,000 runs. The ejecting head was regularly cleaned after each plate making by being immersed in isopropanol under the application of a DC

voltage of 0.5kV for 20sec. By such a cleaning operation, the head operated perfectly for 6 months without any additional maintenance, consistently making high quality plates for printing.

EXAMPLE 1B

Plate making was carried out in the same manner as in Example 1A, except that plate making apparatus 1B was used, dust present on the plate surface was optically detected during image formation to perform removal of the dust on the plate surface by air pump suction in accordance with output signals of the dust detection, foreign matters deposited on the head were watched with detecting the ink meniscus shape at the ejecting head tip, and that vibration was detected from relative vibration obtained by an accelerometer attached to the head and the plate cylinder.

As a result, image deterioration due to dust did not take place at all and the dot area was quite stable under a drifting external atmospheric temperature and with the increase of processed plate number.

The plate thus prepared was used for printing in the same manner as in Example 1A. The resulting lithographic prints had sharp and crisp images free of void or blur even after 10,000 runs.

Ten minutes after the plate making, Isopar G was fed to the ejecting head from the head aperture. Then, the head was kept in a closed space filled with the vapor of Isopar G. By such an operation, the head operated perfectly for 3 months without any additional maintenance, consistently making high quality plates for printing.

EXAMPLE 2B

Plate making was carried out in the same manner as in Example 2A, except that an apparatus as shown in Fig. 14 was used, dust present on the plate material was optically detected during the image formation to perform removal of the dust on the plate surface by a rotating nylon brush in accordance with the output signals of the dust detection, foreign matters deposited on the head were watched with detecting anomaly current of the head, and that vibration was detected from relative vibration obtained by an accelerometer attached to the head and the plate cylinder to stop recording signal sent to the head when an abnormal vibration was detected.

As a result, an excellent image was formed on the plate accompanied with no image defect caused by the presence of dust at all. Also, the dot area was quite stable under a drifting external atmospheric temperature and with the increase of processed plate number. On the

other hand, when a vibration was added to the apparatus intentionally, the voltage application to the ejecting head was temporarily stopped, but with the termination of the vibration, the image recording was re-started, giving a high quality images. The image was thermally fixed with a heat roller made of silicone rubber sealed with Teflon and installed with a 300 W halogen lamp. The roller applied a pressure of 3 kgf/cm^2 (29.4 N/cm^2) to the image to provide a wear-resistant plate.

The plate thus prepared was used for printing as in Example 1A. The obtained lithographic print image was sharp and crisp free of void or blur even after 10,000 runs. In addition, cleaning was carried out after the plate making by circulating Isopar G in the head, and then contacting the head tip with a nonwoven fabric impregnated with Isopar G. By such cleaning operations, the head operated perfectly for 3 months without any additional maintenance, consistently making high quality plates for printing.

Similar results were obtained by using another 600 dpi full line inkjet head having a structure shown in Fig. 8 and Fig. 10 instead of the one shown in Fig. 6.

EXAMPLE 3B

The same operations as made in Example 1B were performed, except that the aluminum plate used in Example 1B was replaced with the plate material used in Example 3A.

As the application of a hot air to the plate caused blistering, fixing was carried out by gradually raising the power supplied to the heater generating the hot air or by decelerating the rotation speed of the drum with a constant power supply. By either method, no blister formed and the finally obtained printed matter was free of void or blur even after 5,000 runs.

According to the invention, plates can be made that can produce a large number of sharp and crisp prints. Further, high quality printing plates corresponding to digital image data can be directly obtained consistently, thus enabling an economical and high-speed printing.

CLAIMS

1. A method of making a printing plate based on image data signals comprising:

directly forming an image on a plate material by an electrostatic inkjet process comprising ejecting an oil-based ink from an ink ejecting head by making use of an electrostatic field;

fixing the image thus formed; and

cleaning said ejecting head by immersing the ejecting head in a cleaning liquid and applying voltage thereto.

2. The plate making method according to claim 1, wherein said oil-based ink comprises:

a non-aqueous solvent having a specific resistance not less than 10^9 Ωcm and a dielectric constant not higher than 3.5; and

a hydrophobic particulate resin dispersed in said solvent, the resin being solid at least at room temperature.

3. A plate making apparatus comprising:

an image forming unit which forms an image directly on a plate material based on image data signals, said image forming unit comprising an inkjet recording unit having an ink ejecting head, which inkjet recording unit

ejects an oil-based ink from an ink ejecting head by making use of an electrostatic field;

an image fixing unit which fixes the image formed by said image forming unit; and

a cleaning member for said ejecting head, which comprises a cleaning liquid and applies a voltage on the ejecting head immersed in said cleaning liquid.

4. The plate making apparatus according to claim 3, wherein said oil-based ink comprises:

a non-aqueous solvent having a specific resistance not less than 10^9 Ωcm and a dielectric constant not higher than 3.5; and

a hydrophobic particulate resin dispersed in said solvent, the resin being solid at least at room temperature.

5. The plate making apparatus according to claim 3 or 4, wherein said image fixing unit comprises a heating member having at least one member selected from a heat roller, an infrared lamp, a halogen lamp and a xenon flash lump.

6. The plate making apparatus according to claim 5, wherein said image heating member is disposed and/or controlled so as to gradually raise the temperature of the plate material upon image fixing.

7. The plate making apparatus according to any one of claims 3 to 6, further comprising a drum onto which said plate material is to be loaded, said drum being rotatable to carry out main scanning.

8. The plate making apparatus according to claim 7, wherein said ink ejecting head comprises a single-channel head or a multi-channel head, each movable in a direction parallel to the axis of said drum to carry out sub-scanning.

9. The plate making apparatus according to any one of claims 3 to 6, further comprising at least one pair of capstan rollers to carry out sub-scanning by conveying said plate material.

10. The plate making apparatus according to claim 9, wherein said ink ejecting head comprises a single-channel head or a multi-channel head, each movable in a direction perpendicular to the conveyance direction of said plate material to carry out main scanning.

11. The plate making apparatus according to claim 7 or 9, wherein said ink ejecting head comprises a full-line head having a length substantially the same as the width of said plate material.

12. The plate making apparatus according to any one of claims 3 to 11, wherein said inkjet recording unit

further comprises an ink feeding member which feeds the oil-based ink to said ink ejecting head.

13. The plate making apparatus according to claim 12, wherein said inkjet recording unit further comprises an ink recovering member which recovers the oil-based ink from said ejecting head to circulate the oil-based ink.

14. The plate making apparatus according to any one of claims 3 to 13, further comprising a dust removing member which removes dust present on said plate material during or prior to said image formation.

15. The plate making apparatus according to any one of claims 3 to 14, wherein said inkjet recording unit further comprises an ink tank for storing the oil-based ink and a stirring member which stirs the oil-based ink in said ink tank.

16. The plate making apparatus according to any one of claims 3 to 15, wherein said inkjet recording unit further comprises an ink tank for storing the oil-based ink and an ink temperature controller for the oil-based ink in said ink tank.

17. The plate making apparatus according to any one of claims 3 to 16, wherein said inkjet recording unit further comprises an ink concentration controller for the oil-based ink.

18. A method of making a printing plate based on image data signals comprising:

directly forming an image on a plate material by an electrostatic inkjet process comprising ejecting an oil-based ink from an ink ejecting head by making use of an electrostatic field;

fixing the image thus formed; and

in the case where an anomaly takes place, at least one of suspending the image formation and eliminating a cause of said anomaly.

19. The plate making method according to claim 1, wherein said oil-based ink comprises:

a non-aqueous solvent having a specific resistance not less than 10^9 Ωcm and a dielectric constant not higher than 3.5; and

a hydrophobic particulate resin dispersed in said solvent, the resin being solid at least at room temperature.

20. A plate making apparatus comprising:

an image forming unit which forms an image directly on a plate material based on image data signals, said image forming unit comprising an inkjet recording unit having an ink ejecting head, which inkjet recording unit ejects an oil-based ink from an ink ejecting head by making use of an electrostatic field;

an image fixing unit which fixes the image formed by said image forming unit; and

at least one of an anomaly detecting member and an anomaly cause eliminating member so that the operation of said image forming unit is at least temporarily suspended and/or said anomaly cause eliminating member operates in response to an output signal from said anomaly detecting member.

21. The plate making apparatus according to claim 20, wherein said anomaly detecting member is a detector that detects adhesion of foreign matters on the ink ejecting head.

22. The plate making apparatus according to claim 20, wherein said anomaly detecting member is a dust detector that detects dust present either or both of in said apparatus and on said plate material.

23. The plate making apparatus according to claim 20, wherein said anomaly detecting member is a vibration detecting device that detects vibration of at least one of said plate making apparatus and said ink ejecting head.

24. The plate making apparatus according to any one of claims 20 to 23, wherein said oil-based ink comprises:

a non-aqueous solvent having a specific resistance not less than 10^9 Ωcm and a dielectric constant not higher than 3.5; and

a hydrophobic particulate resin dispersed in said solvent, the resin being solid at least at room temperature.

25. The plate making apparatus according to any one of claims 20 to 24, wherein said image fixing unit comprises a heating member having at least one member selected from a heat roller, an infrared lamp, a halogen lamp and a xenon flash lump.

26. The plate making apparatus according to claim 25, wherein said image heating member is disposed and/or controlled so as to gradually raise the temperature of the plate material upon image fixing.

27. The plate making apparatus according to any one of claims 20 to 26, further comprising a drum onto which said plate material is to be loaded, said drum being rotatable to carry out main scanning.

28. The plate making apparatus according to claim 27, wherein said ink ejecting head comprises a single-channel head or a multi-channel head, each movable in a direction parallel to the axis of said drum to carry out sub-scanning.

29. The plate making apparatus according to any one of claims 20 to 26, further comprising at least one pair of capstan rollers to carry out sub-scanning by conveying said plate material.

30. The plate making apparatus according to claim 29, wherein said ink ejecting head comprises a single-channel head or a multi-channel head, each movable in a direction perpendicular to the conveyance direction of said plate material to carry out main scanning.

31. The plate making apparatus according to claim 27 or 29, wherein said ink ejecting head comprises a full-line head having a length substantially the same as the width of said plate material.

32. The plate making apparatus according to any one of claims 20 to 31, wherein said inkjet recording unit further comprises an ink feeding member which feeds the oil-based ink to said ink ejecting head.

33. The plate making apparatus according to claim 32, wherein said inkjet recording unit further comprises an ink recovering member which recovers the oil-based ink from said ejecting head to circulate the oil-based ink.

34. The plate making apparatus according to any one of claims 20 to 33, further comprising a dust removing member which removes dust present on said plate material during or prior to said image formation.

35. The plate making apparatus according to any one of claims 20 to 34, wherein said inkjet recording unit further comprises an ink tank for storing the oil-based

ink and a stirring member which stirs the oil-based ink in said ink tank.

36. The plate making apparatus according to any one of claims 20 to 35, wherein said inkjet recording unit further comprises an ink tank for storing the oil-based ink and an ink temperature controller for the oil-based ink in said ink tank.

37. The plate making apparatus according to any one of claims 20 to 36, wherein said inkjet recording unit further comprises an ink concentration controller for the oil-based ink.

38. The plate making apparatus according to any one of claims 20 to 37, further comprising a cleaning member which cleans said ink ejecting head.

39. A plate making method or apparatus substantially as described with reference to the accompanying drawings or examples.

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Application No:	GB 0102491.8	**Examiner:**	David Glover
Claims searched:	1-17	**Date of search:**	16 May 2001

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y, P	EP 0988968 A	(Fuji) see page 9 lines 53-58	1
A	JP 110269416 A	(Fuji) note oil based ink	
Y	JP 110263018 A	(Toshiba) note cleaning of inkjet head using cleaning solution and by applying voltage	1
A	JP 100202822 A	(Fuji) note plate preparation using inkjet	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
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